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ANNUAL REPORT 1992



RESEARCH STATION FOR FRUIT GROWING

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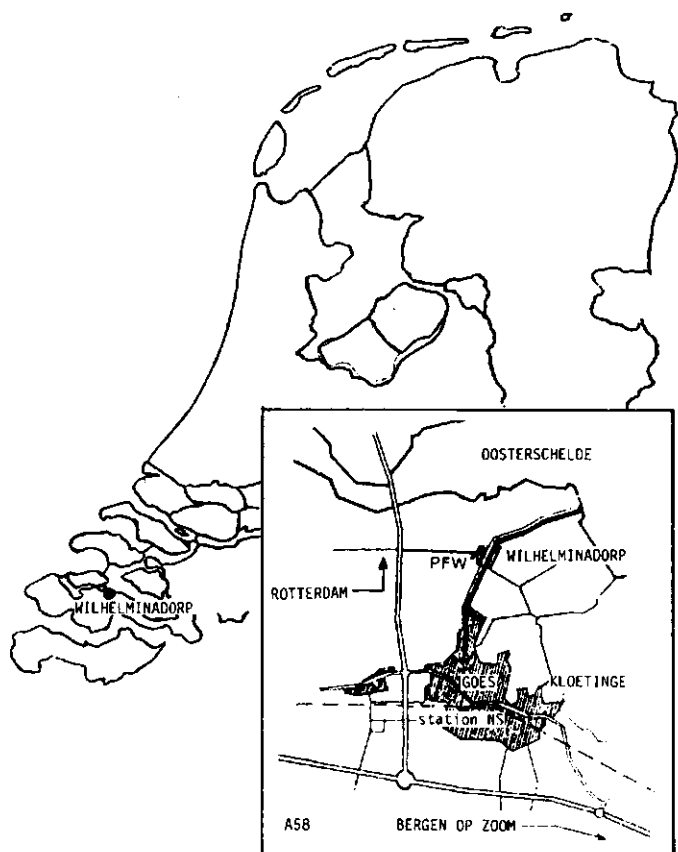
TEL 01100-42500

FAX 01100-42650

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REMARKS ON THE BRANDS OF PESTICIDES AND HERBICIDES

The dosages mentioned for pesticides and herbicides in this report refer to the commercial products. Trade names of products have been used for the sake of convenience, but this makes it unavoidable that in some cases similar products on the market under other trade names are not mentioned. No endorsement of named products is intended.

Some of the experiments described in this report are being carried out with chemicals and/or concentrations not yet legally approved.

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 THE EXPERIMENTAL GARDEN

WEATHER AND FULL-BLOOM DATA

P.S. Wagenmakers and J.L. Baarends

Table 1 lists data on global radiation, precipitation, temperature and full bloom for Wilhelminadorp. Where data for Wilhelminadorp are missing, data for Vlissingen are used instead. Because the location of the latter weather station is closer to the North Sea, differences can occur between the 2 stations. The significance of these on fruit performance is, however, slight.

The first months of 1992 were 1.5 °C warmer than normal and quite dry. May and June had very nice weather. Temperatures were 2-3 °C higher than normal and sunshine in May was also abundant. June was rather wet. Between July and September, patterns were quite normal, although rainfall was abundant in August. October was slightly colder than normal. November and December were normal again.

Table 1. Global radiation, rainfall and temperature at Wilhelminadorp (Wi) and Vlissingen (Vl).

Month	Global radiation (Mj/m ² /month)		Rainfall (mm)		Temperature (°C)	
	1992	1951- 1990	1992	1951- 1990	1992	1951- 1990
	Wi	Vl	Wi	Vl	Wi	Vl
January	65.5	78.8	17.7	65.9	3.1	3.1
February	139.1	143.6	26.3	46.3	5.3	3.1
March	230.3	274.4	59.9	55.9	7.4	5.2
April	404.8	412.0	55.2	45.6	9.2	8.0
May	652.9	563.9	50.0	46.5	15.2	11.9
June	600.7	587.1	113.6	63.6	17.0	14.9
July	561.3	563.4	80.7	68.7	18.2	16.7
August	449.9	489.1	122.2	80.1	18.0	17.0
September	303.4	342.7	66.6	70.9	15.0	15.2
October	184.6	209.6	99.4	81.4	8.8	11.7
November	84.6	97.5	85.1	76.9	8.4	7.2
December	61.6	61.7	58.1	72.9	4.3	4.5

Table 2 lists the full bloom data of some important fruit cultivars for Wilhelminadorp. The data are given for the last 5 years separately and average for the period 1973-1982. Flowering in 1992 was earlier than average.

Table 2. Date of full bloom at Wilhelminadorp. (plum, pear, apple)

Cultivar	1988	1989	1990	1991	1992	1973 - 1992
Opal	18 April	31 March	21 April	8 April	11 April	19 April
Victoria	18 April	1 April	21 April	8 April	12 April	18 April
Conference	20 April	10 April	2 April	12 April	20 April	25 April
D. du Comice	25 April	23 April	2 April	14 April	26 April	30 April
Alkmene	27 April	21 April	12 April	17 April	1 May	5 May
Elstar	4 May	3 May	16 April	29 April	4 May	11 May
Jonagold	4 May	1 May	19 April	29 April	2 May	10 May
Golden D.	6 May	3 May	22 April	25 April	3 May	10 May

DEPARTMENT OF POMOLOGY AND ECONOMICS

TOP FRUIT AND NURSERY

ROOTSTOCKS AND INTERSTEMS FOR POME AND STONE FRUIT

S.J. Wertheim and J.M.T. Balkhoven-Baart

Rootstocks

Apple

M.26 from vitro propagation

In the Annual Report 1988 (p. 30-31) a M.26 trial was summarized. Three types were discussed: a spurred and a non-spurred type of the NAKB (The Netherlands Inspection Service for Arboricultural Produce), and a non-spurred type from the former IVT (Institute of Horticultural Plant Breeding) at Wageningen. It was concluded that there were no significant differences in vigour, productivity or fruit quality. It was not mentioned in that report that there were no significant differences in the trunk circumferences of Golden Delicious "Smoothee" on the 3 types after 8 years. The circumferences were, in the above-mentioned order of M.26 types, 18.8, 19.8, and 19.4 cm. The only difference observed was a slightly smaller number of burr knots on the parts of the non-spurred M.26 which were above the ground.

Table 3. Results M.26-type trial 90.0.25.

M.26 type	Propagation	Trunk circumf. (cm) spring 1990	Growth/ tree (m) 1990 + 1991	Burr knots/ tree 1992	Fruits/ m shoot length 1990 + 1991	Kg/ tree
NAKB spurred	layering	5.2	23.0 a	1.3	2.8	14.2
NAKB spurred	vitro	5.2	22.2 a	1.0	3.0	15.0
NAKB non-spurred	layering	5.1	22.7 a	0.5	2.9	14.8
NAKB non-spurred	vitro	5.2	22.1 a	0.5	3.3	15.5
IVT non-spurred	layering	5.3	22.1 a	0.5	2.9	14.3
IVT non-spurred	vitro	5.2	22.7 a	0.2	2.9	13.8

Values in 1 column followed by the same letter do not differ significantly (P = 0.05).

In 1986 a new trial was started with the same M.26 material, but propagated by a stool bed or by vitro propagation. The aim was to see whether the latter can affect orchard behaviour. One plant of each type was selected from stoolbeds in the experimental garden at Horst. These were multiplied, either by layering or by vitro culture. The latter took place at a special centre at Lisse (COWT) by Ir. B. Kunneman. In the spring of 1988 rootstocks were planted

out in Horst and in August budded with Jonagold "Wilmuta". In November 1988 the rootstocks were lifted and stored in cold storage at -2 °C until spring 1989.

Then the rootstocks were potted into 10-l-containers and grown for 1 year. In the spring of 1990 the 1-year-old trees were planted in Wilhelminadorp at 3.50 x 1.40 m. The trial with 6 treatments (see Table 3) was taken in 6 replications with 4 trees per plot.

Table 3 summarizes the results. At planting, and during the 2 following growing seasons, few differences were recorded between the treatments. The only difference observed was that the spurred type had slightly more burrknots on the rootstock shank. Therefore, the results were similar to the earlier trial and thus vitro propagation did not alter the orchard behaviour. The trial was terminated after the 1992 growing season.

New dwarfing rootstocks

In the spring of 1991 a national rootstock trial was planted with plant material raised in the same nursery. Table 4 lists the trial sites, the test cultivars and the rootstocks the latter in order of increasing growth vigour as indicated by the Elstar trunks measured at the end of 1992 in Wilhelminadorp. The sequence is slightly different for Cox and for the other sites. Tentatively, it can be said that a number of rootstocks equal M.27 or M.9 in vigour or are in between. Some appear to have become stronger than M.9 (Mark, C 6). However, the trial is too young for any conclusions. In early productivity, as expressed by fruit number per cm trunk circumference, M.9 was number one in all cases.

Table 4. Trunk circumference (cm) autumn 1992 apple-rootstock trial 91.0.1.

Rootstock	Country of origin	Elstar			Queen Cox	
		Wi	Nu	Ge	Wi	Nu
AR 10.2.5	United Kingdom	7.5	7.6	6.3	8.9	8.5
P 81	Poland	7.9	7.9	6.3	8.1	7.7
M.27		8.0	7.9	6.3	7.2	7.8
P 59	Poland	8.7	6.9	5.9	8.2	6.8
P 92	Poland	8.8	7.8	6.7	8.4	7.2
MAC 39	USA	8.8	8.1	7.1	9.4	8.5
M.9		9.8	10.2	8.5	9.6	9.0
V 605-3	Canada	9.9	11.2	-	11.0	9.7
P 2	Poland	10.1	10.0	8.6	10.0	10.0
P 60	Poland	10.6	10.4	8.8	10.0	9.1
Mark	USA	11.3	11.3	9.5	10.9	10.6
V 605-1	Canada	11.9	9.9	8.8	9.5	9.6
C 6	USA	12.1	11.1	9.7	11.9	9.5

Bemali and J-TE-series

In the spring of 1986 2 trials were planted with some new rootstocks. In trial 86.0.8 the rootstocks were M.27, M.9 and the Swedish Bemali with Elstar as test cultivar. In trial 86.0.9 with Golden Delicious "Smoothee" as test cultivar, the same 3 rootstocks were included plus 3 selections from the former Czechoslovakia (J-TE-F, J-TE-G, J-TE-H). All 4 new rootstocks were

described as dwarfing. The trees of both trials had to be planted on another site, because of building activities. This will have reduced vigour, but it is assumed that the relationship between rootstocks will have remained the same. In the new trial the planting distance was 3.25 x 1.25 m.

The results with Bemali could be analysed together for both trials as there were no interactions (Table 5), with one exception the mean fruit weight for the period 1987-1992. For Elstar on M.27 these values were 162 g (a), on M.9 178 g (b), and on Bemali 167 g (a). So, larger apples on M.9.

Table 5. Results of rootstock trials 86.0.8 and 86.0.9 for Elstar and Golden Delicious "Smoother" combined.

Rootstock	Tree volume (m ³)	Trunk circumf. (cm)	Kg/		Fruits/	
			m ³ trees	cm trunk	m ³ tree	cm trunk
	spring 1993		volume	circumf.	volume	circumf.
			1987 - 1992			
M.27	0.51 a	15.2 a	106 a	3.7 a	663 a	22.9 a
M.9	0.95 b	18.4 b	72 b	3.6 a	410 b	20.3 b
Bemali	1.18 c	21.1 c	45 c	2.4 b	281 c	15.4 c

Values in 1 column followed by the same letter(s) do not differ significantly (P = 0.05).

Bemali grew more vigorously than M.9 and was less productive. Therefore, Bemali is not of interest for Dutch fruit growing.

The results of trial 86.0.9 are summarized in Table 6, which again shows that Bemali is not a suitable rootstock; it is more vigorous and yields less fruit than M.9, with smaller apples. The same applies to J-TE-H, except for fruit size which was similar to M.9. Of more interest are J-TE-G and F. The former had a similar vigour to M.27. Fruit size was better on J-TE-G, possibly a consequence of the lower number of fruits per m³ tree volume. J-TE-F was of similar vigour to M.9, but yielded less fruit per m³ tree volume.

J-TE-F, J-TE-G plus J-TE-E (not tested before in The Netherlands) will be included in a new trial to be planted in the coming winter.

Table 6. Results rootstock trial 86.0.9 with Golden Delicious "Smoother".

Root- stock	Tree volume (m ³)	Trunk circumf. (cm)	Kg/		Fruits/		Mean fruit weight (g)
			m ³ tree	cm trunk	m ³ tree	cm trunk	
	spring 1993		volume	circumf.	volume	circumf.	
			1987 - 1992				
M.27	0.44 a	12.7 a	124 a	4.6 a	716 a	26.9 a	183 ab
J-TE-G	0.72 b	12.9 a	90 b	4.6 a	495 b	25.1 ab	196 b
M.9	0.82 b	14.9 b	92 b	4.7 a	518 b	26.2 ab	187 b
J-TE-F	0.90 b	15.0 b	75 c	4.3 a	409 c	23.4 a	193 b
Bemali	1.08 c	17.8 c	55 d	3.2 b	342 cd	19.8 c	172 a
J-TE-H	1.23 c	19.0 d	56 d	3.2 b	312 d	18.1 c	190 b

Values in 1 column followed by the same letter(s) do not differ significantly (P = 0.05).

Other species

In the spring of 1989 table grafts of apple were made on Quince MC and seedlings of *Sorbus aucuparia*. Scion wood and rootstocks were virus free. Of each cultivar rootstock combination 10 grafts were made. Table 7 shows that compatibility was poor except for the triploids Jonagold and Rode Boskoop, but even here the final number of surviving grafts was low. So, both Quince MC and the Common Rowan are not suitable as apple rootstocks.

Table 7. Number of surviving trees of apple on Quince MC and Common Rowan (maximum number 10).

Apple cultivar	Quince MC		Common Rowan	
	autumn 1989	autumn 1990	autumn 1989	autumn 1990
Alkmene	0	0	0	0
Cox's Orange Pippin	4	0	0	0
Discovery	8	0	0	0
Elstar	9	0	5	0
James Grieve	7	0	8	0
Jonagold	9	6	10	4
Rode Boskoop	9	8	4	0

If compatibility was good, these species might perhaps be used in the control of specific apple replant disease.

Pear

OHxF-rootstocks

In December 1987 trial 87.1.2 was planted with the pear rootstocks OHxF 51 and OHxF 333 and the control Quince MC. Test cultivars were Conference and Doyenné du Comice. The plant material was 2 years old and the planting distance 3.50 x 1.64 m. The treatments were replicated 7 times with 1 tree per plot for each cultivar. From spring 1988 onward 3 replicates of Conference and

Table 8. Results pear-rootstock trial 87.1.2.

Treatment	Tree volume (m ³) spring 1993	Increase in trunk circ. (cm) 1986 - 1993	Fruits/tree 1988 - 1992	Kg/tree	Fruits/m ³ tree volume	Fruits/cm trunk circumf.	Fruit weight (g)
Quince MC	1.17 a	14.3 a	195 a	36.4 a	173 a	10.4 a	248 a
OHxF 51	1.50 ab	16.7 b	152 b	30.5 b	100 b	8.0 b	262 a
OHxF 333	1.85 b	19.2 c	164 b	30.1 b	95 b	6.9 b	248 a
LSD	0.33	1.7	22	5.3	34	2.0	18
- CCC	1.80 p	17.7 p	189 p	35.5 p	108 p	9.2 p	246 p
+ CCC	1.22 q	15.8 q	152 q	29.2 q	138 q	7.6 q	259 q
LSD	0.38	1.2	16	3.3	27	1.2	7

Values in 1 column (per table part) followed by the same letter(s) do not differ significantly ($P = 0.05$). LSD at $P = 0.05$).

4 of Doyenné du Comice were sprayed annually with the growth retardant chloromequat (CCC). Spraying was carried out twice each year (at the end of flowering and 2 weeks later) with 1600 ppm active ingredient.

Both cultivars produced a similar reaction to rootstock and growth-retardant treatment. Therefore, the results of both cultivars could be analysed together (Table 8) giving strength to the conclusions. Both OHxF-rootstocks were more vigorous than Quince MC and were less productive. In fruit size all rootstocks were equal. Chloromequat reduced vigour and increased productivity per m³ tree-crown volume, but not per cm trunk circumference. Fruits were slightly larger after CCC treatment.

Because of the vigour of both OHxF-rootstocks they are not suitable for the rather intensive method of pear growing used in The Netherlands. This is a pity since they are resistant to fire blight and pear decline and compatible with all pear cultivars. The trial has been terminated.

OH rootstocks

In the spring of 1991 the pear-rootstock trial 91.1.1 was planted in Wilhelminadorp and in the French research station at Beaucouzé near Angers. All trees were raised in Beaucouzé. In Wilhelminadorp the test cultivars were Conference and Pierre Corneille; in Angers only the former. The rootstocks are mentioned in Table 9. Quince MC, BA 29, and OHxF 333 serve as standards; the latter 2 by French request. BA 29 has been investigated earlier in Wilhelminadorp and is considered too vigorous (see *Fruittelte* 82(1992)44:12-13). The same applies for OHxF 333 (see this Annual Report p. 17).

Table 9. Kg per tree 1992 pear-rootstock trial 91.1.1.

Rootstock	Conference	Pierre Corneille
Quince MC	3.4	1.1
BA 29	1.0	0.9
OHxF 333	0.6	0.2
OH 11	1.5	1.5
OH 20	0.6	0.0
OH 33	0.1	0.6

The OH-numbers are French seedlings of Old Home, which are being considered as potential dwarfing rootstocks. The treatments are replicated 4 times with 3 trees per plot at a distance of 3.50 x 1.50 m.

In 1922 the trees produced their first crop (Table 9). Quince MC and OH 11 were the most precocious rootstocks. Trees on all rootstocks, except Quince MC, had secondary flowering in 1992, especially on OH 11 and OH 33. For fire-blight risks this is a drawback.

RV 139 and QR 193/16

In the spring of 1991 the pear rootstock trial 91.1.2 was planted comparing Quince MC with 2 new rootstocks (Table 10). Plant material was 1 year old and was raised at the same nursery. RV 139 is a French *Pyrus* rootstock which is considered to be dwarfing. QR 193/16 is an English selection from Quince that has a positive effect on the fruit shape of Conference pears. RV 139 proved difficult to propagate even in vitro culture, but thanks to Ir. B. Kunneman from the Research Station for Nursery Stock at Boskoop enough rootstocks were

obtained. There were many losses during the various stages from vitro culture to budding in the nursery. Even the budding failed completely one season and was repeated the following summer. Coupled with the extremely slow development of the trees after planting, expectations do not run high. The lack of fruits in 1992 (Table 10) is a sign of the poor tree development. QR 193/16 gave some pears in 1992 but less than Quince MC.

Table 10. Kg per tree 1992 in pear-rootstock trial 91.1.2.

Rootstock	Conference	Doyenné du Comice	Beurré Hardy	Gieser Wildeman
Quince MC	4.9	1.5	0.0	3.7
RV 139	0.0	0.0	0.0	0.0
QR 193/16	0.4	0.1	-	-

Lescovacs and QR 193/16

In the autumn of 1991 rootstock trial 92.1.1 was planted with Conference and Doyenné du Comice as test cultivars. The plant material was 2 years old and raised in one nursery. The plant material is listed in Table 11. QR 193/16 has been introduced in the former trial. Lescovacs is the only Quince cultivar, from a fairly large number, that withstood the sudden severe frost of January 1985 without damage. So, it might be suitable as a more winterhardy rootstock than Quince MC, if vigour and cropping are acceptable.

Table 11. Trunk circumference (cm) spring 1992 pear-rootstock trial 92.1.1.

Rootstock	Virus status	Conference	Doyenné du Comice
Quince MC	virus free	5.7	6.4
Lescovacs	unknown	4.9	5.7
QR 193/16	virus free	4.1	5.2

The trees on Quince MC were larger than those on the other 2 rootstocks; this is expressed in the trunk size (Table 11). For Lescovacs virus might be involved as the virus status is as yet unknown. This does not hold for QR 193/16 which is virus free. If the vigour on Lescovacs and QR 193/16 proves to be permanently lower, this will be very welcome.

Table 12. Number of surviving trees of pear on M.9, *Amelanchier* and Common Rowan (maximum number 10).

Pear cultivar	M.9	<i>Amelanchier</i>	Common Rowan	
	-----	-----	-----	-----
	autumn 1989	autumn 1989	autumn 1989	autumn 1991
Conference	0	0	9	7
Doyenné du Comice	0	0	10	6
Gieser Wildeman	2	0	9	8
Saint Rémy	5	0	8	6
Triomphe de Vienne	0	0	9	6

Other species

In the spring of 1989 table grafts were made of pear on *Amelanchier alnifolia* "Smoky", seedlings of *Sorbus aucuparia*, and the apple rootstock M.9. The latter 2 were virus free, the former of unknown virus status. The 5 pear cultivars were virus free. Table 12 shows that only on the Common Rowan was some success scored. However, even here the leaves did not look very healthy, so the trees might not have survived for long. The trial has been terminated, because the survival rate was considered too low.

Plum

In the spring of 1990 the plum-rootstock trial 90.3.1 was planted with 9 (Victoria) and 5 (Opal) rootstocks (Table 13). St. Julien A serves as standard rootstock. *Prunus dasycarpa* and *P. blereana* were included to see whether these could lower the vigour. Two selections of *Prunus cerasifera* (Myrobalan) were included: Hollywood and Myruni. The former was included because in Wilhelminadorp it forms a fairly small ornamental tree that produces a good annual crop of large fruits. Myruni is a German selection, formerly named Uhl 76/15, which is being marketed, but without much information on its merits. Marianna INFEL GF 8/1, Reine Claude INFEL, and Ishtara are French rootstocks. It was felt necessary to study their behaviour under Dutch conditions, although GF 8/1 has already been found to be too vigorous in a previous trial with Opal (see Annual Report 1988: p. 18). Finally, Marianna 2624 is an American rootstock whose values under Dutch conditions are also unknown.

Table 13. Results 1992 plum-rootstock trial 90.3.1.

Rootstock	Opal			Victoria		
	Trunk circumf. (cm)*	Kg/ tree	Fruit weight (g)	Trunk circumf. (cm)*	Kg/ tree	Fruit weight (g)
St. Julien A	21.7	0.45	38	22.6	4.03	60
<i>P. dasycarpa</i>	21.1	0.17	39	22.0	0.98	57
Hollywood	21.4	0.29	37	24.6	4.64	53
Myruni	22.6	1.00	37	22.8	3.06	55
Marianna GF 8/1	24.9	0.68	31	22.9	3.97	52
Reine Claude INFEL				22.3	2.01	51
Ishtara				21.7	8.99	57
<i>P. blereana</i>				11.2	3.76	54
Marianna 2624				21.8	7.57	60

* Spring 1993.

All rootstocks, except *P. blereana*, induced rather strong vegetative growth as can be derived from the trunk circumferences of spring 1993 (Table 13). The trees did not crop in 1991, but did in 1992. Victoria, Ishtara and Marianna 2624 cropped well. *P. blereana*, to date, has been the most dwarfing stock, but the leaves looked paler than those on the other rootstocks. Marianna 2624, also, did not have very healthy looking leaves. It is too early for conclusions.

Cherry

Trial 88.2.1 planted in the spring of 1988 with some new rootstocks has reached a stage at which differences in growth vigour are clearly visible (Table 14). The results of all 4 test cultivars could be combined. Therefore, the last column in Table 14 gives a good picture of vigour sequence. Inmil, Damil, and Camil clearly grew less than the others, especially Inmil. The Weiroot numbers were less vigorous than Colt with Stella and Merton Glory, but with Castor and Early Rivers were equally vigorous. Weiroot 10 is the least vigorous of the two. The Weiroot numbers are not dwarfing rootstocks. The leaves on Damil and Camil were not as healthy as on the other rootstocks, which might indicate moderate compatibility.

Table 14. Trunk circumference (cm) spring 1993 cherry-rootstock trial 88.2.1.

Rootstock	Merton Glory	Castor	Stella	Early Rivers	Average
Inmil	20.5 a	15.4 a	16.3 a	13.3 a	16.4 a
Damil	23.9 a	25.2 b	25.8 b	22.7 b	24.4 b
Camil	33.4 b	26.8 b	28.0 b	25.9 b	28.5 c
Weiroot 10	41.5 c	37.4 c	33.8 c	34.6 c	36.8 d
Weiroot 13	44.2 cd	38.6 c	37.2 d	35.9 c	39.0 e
Colt	46.3 d	38.9 c	42.1 e	33.2 c	40.1 e

Values in 1 column followed by the same letter(s) do not differ significantly ($P = 0.05$).

The productivity of the Weiroot rootstocks was especially good. Production on Inmil was too low and fruit size was not as good as on the other stocks in 3 out of the 4 cultivars (Table 15). When considering the production figures, it must be kept in mind that the trees differed in size. So, part of the production differences reflect tree-size differences.

Table 15. Kg per tree and mean fruit weight (g) 1992 in cherry-rootstock trial 88.2.1.

Rootstock	Merton Glory		Castor		Stella		Early Rivers	
	kg	g	kg	g	kg	g	kg	g
Inmil	1.1	6.7	0.7	6.5	1.7	6.9	0.1	5.1
Damil	3.1	7.5	3.8	8.2	9.5	8.9	1.3	6.1
Camil	6.7	6.4	5.6	7.7	12.0	7.6	1.3	5.9
Weiroot 10	12.0	6.5	5.2	7.2	17.3	7.8	3.3	5.7
Weiroot 13	15.5	6.1	6.2	7.2	24.7	7.5	3.6	5.6
Colt	5.4	7.7	5.2	8.1	22.9	8.8	1.6	5.9

Trial 89.2.1, also, shows growth differences now (Table 16). All Gisela numbers grew less vigorously than F 12/1. Gisela 1 was the most dwarfing of the series. Differences between Gisela 5 and 10 were, on average, not significant.

More trees have died on Gisela 1 and 10 than on Gisela 5. Incompatibility

is probably the reason. The indices in Table 16 show the number of dead trees out of 6. For this reason and because of better productivity Gisela 5 is the most interesting of the 3 selections.

Table 16. Trunk circumference (cm) spring 1993 cherry-rootstock trial 89.2.1.

Rootstock	Merton Glory	Castor	Stella	Early Rivers	Average
Gisela 1	10.6 ¹ a	12.3 a	9.4 ¹ a	12.3 a	11.3 a
Gisela 5	16.4 ¹ b	20.8 ¹ b	21.3 ² c	18.8 ¹ b	19.3 b
Gisela 10	20.8 ³ b	16.6 ¹ b	18.5 ² b	18.7 ¹ b	18.7 b
F 12/1	32.4 c	29.0 c	29.4 d	27.9 c	29.7 c

Index: number of dead trees out of 6.

Values in 1 column followed by the same letter do not differ significantly (P = 0.05).

Interstems

Apple

Wycik interstem

Wycik is a columnar growing compact mutant of McIntosh. In a trial the value of Wycik as an interstem was investigated. It might be that the compact growth habit is expressed in a scion cultivar grafted onto Wycik. In a trial 4 treatments (Table 17) were compared with 4 replicates with 4 trees per plot. The treatments were carried out as follows. In the spring of 1989 1-year-old Wycik grafts on the vigorous Swedish rootstock A2 were planted at 3.70 x 0.75 m. The following spring the stems were grafted with Cox's Orange Pippin T 12 at a height of 50 cm. At grafting time spurs on the Wycik interstems were or were not removed by pruning. In the latter case a varying number of spurs was maintained (1/3, 2/3 or all of the spurs present). This was done to see whether (a varying number of) leaves on the interstem affect growth.

Table 17. Growth and productivity of Cox's Orange Pippin on Wycik interstem.

Leaves on interstem 1992			Growth/ tree (m)	Mean shoot length (cm)	Trunk circumf. (cm)*	Fruits/ tree**	Fruit weight (g)**
number	total cm ²	cm ² / leaf					
0.0	0.0	-	19.20 a	47	10.8 a	31.6 a	177 a
44.1	57.8	12.5	16.19 a	45	11.9 a	24.8 a	202 a
43.3	66.2	14.7	16.21 a	44	10.3 a	33.1 a	177 a
111.7	165.7	14.8	18.24 a	52	11.8 a	21.4 a	192 a

* Autumn 1992.

** 1992.

Values in 1 column followed by the same letter do not differ significantly (P = 0.05).

Table 17 shows that trees of all treatments grew equally. The vigour of the Cox's Orange Pippin was much greater than is normal on M.9 rootstock. So, the Wycik interstem did not reduce or change the growth habit of the Cox scion.

In early cropping and fruit size, too, all treatments were similar. Given these results it was decided to terminate the trial.

Pear

In the spring of 1989 a national pear-interstem trial was planted in Wilhelminadorp, Numansdorp, and Zeewolde as well as in the National Research Garden at Velm (Belgium). The aim was to see whether winterhardy pears used as an interstem can increase the winterhardiness of the tree, as has been found with apple (see De Fruitteelt 75(1985)49:1376-1380) and how these rootstocks affect growth and cropping. The test cultivars were Conference and Doyenné du Comice, the rootstock was Quince MC. Interstems were chosen from cultivars with a good record of hardiness. Trees with Beurré Hardy interstems and without interstems served as controls. Because of lack of material not all interstems occur on all sites. Table 18 shows the most extensive trial, that at Wilhelminadorp with Conference. The treatments are arranged in order of decreasing vigour. Since the vigour on some interstems was too low and some of these were not present on all sites, the number of treatments was reduced after 1992 to the ones given in Table 19 (plus the virus free Flemish Beauty that occurs in Wilhelminadorp and Velm only).

Table 18. Results pear-interstem trial 89.1.2 with Conference in Wilhelminadorp.

Interstem	Virus status**	Tree volume (m ³) autumn 1992	Fruits/m ³ 1991 + 1992	% trees with early leaf discoloration*
-	vf	0.96 a	169 ab	0
Old Home 14.1	vt	0.91 ab	176 ab	7
Beurré Hardy	vf	0.91 ab	154 a	0
Old Home 13.1	vt	0.88 ab	160 a	0
Ottawa 291	vt	0.82 abc	147 a	13
Doyenné du Comice	vf	0.77 bc	216 ab	0
Old Home (Canada)	vf	0.76 bc	164 ab	0
Nouveau Poiteau	vf	0.65 cd	217 ab	13
Beurré Gris	vt	0.50 de	232 ab	33
Flemish Beauty	vf	0.45 e	246 abc	0
Ure	vt	0.43 e	150 a	100
Alebypäron	nvt	0.42 ef	207 ab	7
Moe	vt	0.25 fg	275 bc	40
Sormlandspäron	nvt	0.14 gh	341 c	31
Beurré d'Anjou	vf	0.14 gh	317 c	33
Rörstrand	nvt	0.05 h	880 d	27

* From 15 to 16 trees. ** vf = virus free, vt = virus tested, nvt = not virus tested.

Values in 1 column followed by the same letter do not differ significantly (P = 0.05).

Table 18 shows that all interstems reduced vigour, albeit not to a significant degree in all cases. However, this effect may partly be a

consequence of the differences in plant material. Trees without an interstem were the heaviest. But differences also occurred between interstems. These may have been caused partly by virus, but differences remained even between virus free trees. The figures on first cropping are given but are not of great value; the trees still have many years to go. The data on early autumn discoloration of the leaves may reflect differences in compatibility. Virus may be another factor, but even between virus free combinations discoloration differed.

Table 19 gives the average tree volume measured at the end of 1992 for all sites and the 2 cultivars. Combination of the data was possible because there were no interfering interactions. Thus, Table 19 gives a good picture on the vigour effect of the various interstems. The data show that interstems can contribute to growth control.

Table 19. Tree volume (m³) autumn 1992 average for 4 sites and 2 cultivars in pear-interstem trial 89.1.2.

Interstem	Virus status**	Tree volume (m ³)
-	vf	1.00 a
Beurré Hardy	vf	0.86 b
Doyenné du Comice	vf	0.82 b
Old Home (Canada)	vf	0.78 b
Nouveau Poiteau	vf	0.70 c
Beurré Gris	vt	0.52 d
Beurré d'Anjou	vf	0.43 e
Moe	vt	0.32 f

Values followed by the same letter do not differ significantly (P = 0.05).

** see Table 18.

Plum

In the spring of 1992 plum-rootstock trial 92.3.1 was planted. One treatment of interest is St. Julien A rootstock with an interstem of Pixy. The latter is a rootstock that induces less growth than St. Julien A, but gives smaller fruits with several cultivars. It is hoped that Pixy as an interstem might reduce vigour without the negative effect on fruit size. Plant material of the interstem trees was lighter than that of the control (Table 20).

Table 20. Quality of plant material plum-rootstock trial 92.3.1.

St. Ju- lian A + or - Pixy interstem	Bleue de Belgique		Victoria		Reine Claude d'Althan		Reine Claude d'Oullins	
	shoots/ tree	length (cm)*	shoots/ tree	length (cm)*	shoots/ tree	length (cm)*	shoots/ tree	length (cm)*
-	9.7	65	7.3	81	9.0	55	12.5	61
+	4.7	30	6.8	71	5.4	34	5.5	54

* Average shoot length.

However, the trees are not really comparable because the interstem trees were 2 years old and those directly on St. Julien A, 1 year old. However, the difference in size gives some hope for future growth control.

UNUSUAL FRUIT CROPS

S.J. Wertheim, J. Dijkstra and H. Kemp

Hazelnut (*Corylus sp.*) - S.J. Wertheim

In 1992 the cultivar trial from 1981 still contained 5 cultivars (Table 21). The others were grubbed because of low productivity. Gunslebert proved the most fertile cultivar with, on average, 3.02 kg good nuts per tree for the years from 1983 until 1992. Next followed Impératrice Eugénie with 2.00 kg, Longue d'Espagne with 1.93 kg, Merveille de Bollwiller with 1.54 kg, and Pearson's Prolific with 1.48 kg. The latter cultivar was grubbed after the 1992 harvest because production was too low and the percentage of nuts that fall from the husk was too low as well. Merveille de Bollwiller was kept in spite of similar productivity, because kernel quality was excellent.

The first 3 cultivars mentioned above can reach the economic threshold production of 2 tonnes of good nuts per ha, calculated from the year when the trees start to bear. This calculation was made with 800 to 1,000 trees per ha. Both Impératrice Eugénie and Longue d'Espagne have the disadvantage of poor pellicle removal from the kernels during roasting (Table 21). This is a serious limitation with regard to industrial processing. In 1992, also, the pellicle removal with Gunslebert was low. In a second series the removal index was better (6.7) than the one given in Table 21. Gunslebert is good in free husking.

Table 21. Results 1992 hazelnut trial 81.8.1.

Cultivar (age at planting* years)	Nuts/ tree total	% empty nuts	% nuts with- out husk	Kg/ tree good nuts**	% moist nuts ***	% kernel ****	Pellicle removal index *****
Gunslebert (2)	1767	5	91	6.09	19	49	3.8
Imp. Eugénie (2)	2610	0	57	5.55	17	57	1.9
Longue d'Espagne (1)	1478	6	25	4.53	17	50	1.0
Merveille de B. (1)	772	4	57	3.34	15	45	8.0
Pearson's Prolific (1)	1774	5	21	3.43	9	51	5.8

* Layers.

** Fresh weight shortly after harvest.

*** After 24 hours at 45 °C.

**** Net output: kernel weight/weight good nuts x 100.

***** After 25 minutes at 175 °C in an oven.

The cultivar trial planted in the spring of 1982 has also been reduced. The cultivars present in 1992 are given in Table 22. From 1993 onwards only Butler, Gustav's Zeller, Lang Tidlig Zeller, Negret, and Tombul will remain. The former 3 because the cropping level is good, the latter 2 because they serve as standards, being important foreign cultivars. On average for the period 1985 - 1992, Butler yielded 2.44 kg good nuts per tree, Gustav's Zeller 2.59, and Lang Tidlig Zeller 2.87. This seems adequate for the level mentioned earlier of 2 tonnes per ha with 800 to 1,000 trees per ha. The main drawback of Butler is its poor pellicle removal. With Lang Tidlig Zeller, too, this feature is rather poor (Table 22). So in fact, Gustav's Zeller is the only

cultivar which is satisfactory for both quantity and quality.

Table 22. Results 1992 hazelnut trial 82.8.1.

Cultivar (age at planting* years)	Nuts/ tree total	% empty nuts	% nuts with- out husk	Kg/ tree good nuts**	% moist nuts ***	% kernel ****	Pellicle removal index *****
Butler (2)	1397	25	95	5.15	19	50	2.5
Gustav's Zeller (2) ^{oo}	1389	8	64	5.67	17	46	8.0
Istarski Dugi (2)	1140	13	18	3.60	8	46	8.0
Lang Tidlig Zeller (3)	1841	21	96	4.95	15	46	5.5
Negret (2)	3458	10	90	6.22	12	49	8.5
Palaz (2)	1163	10	34	2.39	15	40	6.5
Tombul (1)	1238	16	11	2.02	8	52	8.0
Webb's Prize Cob (2) ^o	1119	10	17	3.21	13	47	1.0
White Filbert (2) ^{oo}	1578	38	9	1.64	8	49	7.4
Witpit L. (2) ^{oo}	760	22	13	1.30	11	52	7.7

^o On rootstock *C. avellana*. ^{oo} Ditto on *C. columna*; other layers.
For legenda see Table 21.

The cultivars Istarski Dugi, Palaz, Webb's Prize Cob, White Filbert, and Witpit Lambertsnoot were grubbed after the 1992 harvest. The productivity of Istarski Dugi was too low (1.55 good nuts per tree from 1990 onward) and it had poor free husking. Palaz yielded only 0.74 kg in the same period and did not fall from the husk either. Webb's Prize Cob White Filbert, and Witpit Lambertsnoot yielded 1.57, 1.12, and 1.38 kg of good nuts per tree averaged for the years 1985 - 1992. This is too low. All 3 cultivars are also poor in free husking and Webb's Prize Cob is poor in pellicle removal in addition to that. Negret and Tombul will be kept, not because of their high productivity, but since they are main cultivars in Spain and Turkey respectively. Negret yielded 1.60 kg good nuts per tree (1985 - 1992), and Tombul only 0.36 (1990 - 1992). Negret, however, is more fertile than can be ascertained from the kg production. The nut is small and the number of nuts can be very high (Table 22). Moreover, nut quality is excellent.

Table 23. Results hazelnut trial 83.8.1.

Cultivar (age at planting* years)	Nuts/ tree total	% empty nuts	% nuts with- out husk	Kg/ tree good nuts**	% moist nuts ***	% kernel ****	Pellicle removal index *****
Morell (1)	1103	13	70	2.55	17	47	7.0
Mortarella (1)	1290	23	77	2.98	10	49	7.0
Romai (1)	1148	8	62	3.63	22	64	6.3
Tonda Romana (1)	1242	11	43	3.54	14	49	6.3

Legenda see Table 21.

In the trial planted in the spring of 1983 4 of the 6 original cultivars remain (Table 23). Lansing and Jemstegaard 5 have been grubbed because of low productivity. In 1992 the cropping level was good, but on average for the

years from 1985 until 1992 only Mortarella produced adequately: 2.41 kg of good nuts per tree per year. Morell (1.55 kg), Romai (1.61 kg), and Tonda Romana (1.07 kg) were less productive. Mortarella also scored well in other features (Table 23).

The trees from the trial planted spring 1988 cropped for the first time in 1992 (Table 24), although Tonda di Giffoni had already produced some nuts in 1990. The planting year is not the same for all cultivars, but this is not too serious since the first goal is to find cultivars that yield on average 2 tonnes per ha. Mutual comparison is only secondary. The 1992 production was rather low but the trees are still small. Tonda di Giffoni was the most productive cultivar. The figures of Casina show that bearing may start in third leaf. The same was true with Tonda di Giffoni and with all cultivars in the trial from 1981.

Table 24. Results hazelnut trial 88.8.1.

Cultivar (age at planting* years)	Nuts/ tree total	% empty nuts	% nuts with- out husk	Kg/ tree good nuts**	% moist nuts ***	% kernel ****	Pellicle removal index *****
Camponica (1)	246	18	62	0.93	15	45	8.5
Casina (1)#	58	10	84	0.11	20	57	7.7
Nocchione (1)	337	20	47	0.95	15	48	7.0
Pauetet (1)	340	7	77	0.75	17	47	7.2
Tonda di Giffoni (1)	608	19	29	1.77	16	46	8.3
Tonda Gentile delli Langhe##	209	20	81	0.47	18	49	8.0

Planted spring 1990. ## Ditto spring 1987. The other cultivars in 1988.
Legenda see Table 21.

The trees of the new trial planted in 1989 and 1990 produced their first nuts in 1992. The Dutch cultivar Emoa I from the 1989 trial was the best with 59 nuts per tree. In the 1990 trial the American OSU 23-17 was the most productive with 39 nuts per tree. This is again proof that hazelnut trees can start bearing in the third year.

Japanese pear (*Pyrus pyrifolia*) - H. Kemp

The cultivar trial with 9 Japanese pear cultivars was grubbed in winter 1992/1993, also because of the differences in tree growth. Eight cultivars were planted again on the rather vigorous rootstock *Pyrus betulifolia* in the spring of 1990. On this rootstock the tree growth is more regular and stronger than on Quince MC with an interstem. Only Niitaka gave a first small yield in 1992.

All the grubbed cultivars were planted as 1-year-old graftings on Quince MC; 7 cultivars with an interstem of Beurré Hardy (planted 1985) and 2 with an interstem of Doyenné du Comice (planted 1988). In 1992 fruit thinning again proved to be necessary. Taking into consideration accumulated yield, average fruit weight (Table 25) and regularity and earliness of bearing, Niitaka obviously appears to be the best. Kosui is also good. Chojuro alone has an eating quality that approaches the quality requirements of the Dutch consumers. All the other cultivars are too insipid and too watery, with occasionally an unpleasant after taste.

Table 25. Yield, average fruit weight (g) and flowering period of 7 Japanese pear cultivars planted in Wilhelminadorp.

Cultivar	Planted (spring)	Yield (kg/tree)	Average fruit weight (g)	Flowering period

1986 - 1992				

Hosui	1985	16	165	early
Kosui	1985	39	183	late
Niitaka	1985	64	185	early
Shinko	1985	22	151	early
Shinseiki	1985	37	128	mid season
Shinsui	1985	24	135	mid season
				or late
Tama	1985	17	121	late
Chojuro	1988	9	192	mid season
Nijisseiki	1988	-	85	mid season

The flowering period of Conference and Bonne Louise d'Avranches is approximately the same as that of Shinsui and Tama.

Actinidia-species - J. Dijkstra

Kiwi (*Actinidia deliciosa*)

Winter pruning was delayed till after regrowth in spring. Buds developed mainly towards the ends of the branches resulting in bare lower parts of the branches. Production was good: cvs Bruno and Monty produced 30 kg/plant. Yield of Hayward was much less, only 6 kg/plant. As in previous years fruits of Hayward were much larger than those of Bruno and Monty (110 g and 54 g respectively). The trial was terminated after the harvest of 1992.

Siberian gooseberry (*Actinidia arguta*)

The bushes were pruned only very slightly during the winter. Again, spring frosts damaged the bushes. Even so, the cultivar Ananasnaya gave a good crop (8.15 kg/plant with 75 % first quality). The relatively high percentage of second quality fruits was caused by insufficient pollination because of an unequal flowering of the male and female plants. With 10.3 g, fruit size was quite good.

Mandsjourian gooseberry (*Actinidia kolomikta*)

Again, the Russian winterhardy cultivars were damaged severely by spring frosts. There was no yield at all. Therefore, in spring 1992/'93 a new trial was planted on a field where irrigation against spring frosts is possible.

FRUIT-TREE NURSERY RESEARCH

S.J. Wertheim and J.M. de Groene

Most trials in 1992 were carried out within the framework of another research project (see p.78). One trial was carried out in this project in 1992 in a nursery at 's Gravenpolder. The aim was to study the effect of growth-retarding treatments on the growth of Elstar. In the nursery, Elstar continues to grow until late in the autumn. As a consequence, the tips of stems may freeze during the winter and may later become too long, leading to bare basal parts.

In the trial, laterals were shortened by pruning in either mid-August or mid-September. This was done to improve bud formation on the basal parts of these laterals (see Annual Report 1991; p. 28). Laterals longer than 50 cm were halved, shorter ones were shortened by a third. Root pruning was a second treatment. Again, this was done in mid-August or mid-September. Root pruning was carried out with a spade on either side of the trees at a distance of 10 cm and a depth of 25 cm. A third treatment consisted of 3 consecutive sprays with 0.05 % Ethrel A at 10 day intervals. The first spray was either made in mid-August or mid-September. Combinations of the treatments occurred as well (Table 26). The trial was made in 8 replications with 3 trees per plot.

Table 26. Results 1992 growth-inhibition trial 92.0.227 with Elstar.

Treatment	Tree length (cm)*	Trunk dia- meter (mm)	Laterals/tree		Total length laterals (cm)	Average length laterals (cm)
			> 10 cm	< 10 cm		
1. Control	135	16	9.3	1.0	459	50
2. Aug. pruning	138	15	8.3	1.0	254	31
3. Sept. pruning	140	16	8.6	0.9	253	29
4. Aug. root pruning	134	16	8.9	0.9	449	51
5. Sept. root pruning	132	16	9.0	1.0	488	54
6. Aug. Ethrel A	136	16	8.5	1.0	464	54
7. Sept. Ethrel A	135	16	8.3	1.0	382	46
8. 2 + 4	136	16	8.8	1.3	259	30
9. 2 + 6	136	16	8.8	1.6	271	31
10. 4 + 6	133	17	8.6	1.1	452	52
11. 3 + 5	134	15	8.0	1.4	226	28
12. 3 + 7	133	16	8.4	1.3	228	28
13. 5 + 7	134	16	9.0	1.3	446	50
14. 2 + 4 + 6	134	16	8.6	0.4	259	30
15. 3 + 5 + 7	130	16	8.5	1.0	237	28

* From union.

Table 26 shows that neither root pruning nor the use of Ethrel A had any effect on the growth. Apparently it is difficult to stop the vegetative development of Elstar. Of course, pruning shortened the laterals. Hardly any regrowth occurred. All trees have been planted in an orchard for further evaluation.

PLANTING SYSTEMS AND LIGHT UTILISATION

P.S. Wagenmakers, F. Nijse and C.M.E. de Gendt

Planting systems trial with Elstar - P.S. Wagenmakers and F. Nijse

In this trial, 3 planting densities were studied, each at 3 rectangularities (ratio of spacing between rows: spacing within rows) and 3 tree heights (Table 27). The trial was planted in spring 1983 at Wilhelminadorp, Werkhoven, and Aarslev (Denmark). Were finished at the end of 1989 and 1992 at Werkhoven and Wilhelminadorp, respectively. This report discusses results for Wilhelminadorp and Aarslev. Results of Werkhoven showed tendencies similar to the other locations until 1989.

Table 27 shows production per location and treatment for the whole period and for the last 4 years. Averaged for all treatments, total production was 21 % higher at Wilhelminadorp than at Aarslev. Total production increased with density, although differences between densities were small at Aarslev in later years. For a given density, production increased with decreasing rectangularity. Differences between 1:1 and 2:1 systems were smaller than between 1:1 or 2:1 designs and the higher rectangularity, particularly in later years. Averaged for the last 4 years, 1:1 and 2:1 systems produced 15 % more than 3:1 systems. During the same period, the highest trees (2.25 m) produced 23 % more than lower trees. Between trees of 1.50 m or 1.88 m, differences in production were only slight.

Table 27. Production Elstar (1984-1992 and 1989-1992). Wi=Wilhelminadorp, Aa=Aarslev.

	Ton/ha 1984-1992			Ton/ha 1989-1992		
	Wi+Aa	Wi	Aa	Wi+Aa	Wi	Aa
Trees/ha						
2000	285 a	297 a	263 a	162 a	164 a	157 a
2667	326 b	345 b	290 b	177 b	184 b	164 a
4000	369 c	400 c	306 c	187 c	198 c	164 a
Rectangularity						
1:1	340 b	359 b	304 c	183 b	187 b	173 b
2:1	334 b	358 b	287 b	182 b	192 b	164 b
3:1	306 a	325 a	267 a	161 a	167 a	148 a
Height (m)						
1.50	311 a	327 a	282 a	162 a	164 a	159 a
1.88	318 a	341 b	272 a	168 a	176 a	153 a
2.25	351 b	374 c	305 b	196 b	207 b	173 b

Values followed by similar letter within a sub-column do not differ significantly ($P = 0.05$).

In 1990, 1991, and 1992 fruit colour was graded at Wilhelminadorp for the lower and upper tree halves. Results are expressed as a colour index, composed from the percentage of fruit in different grading classes (0-10, 10-33, 33-50 and 50-100 % red blush), multiplied by a value per class (1, 2.5, 5.5, and 6, respectively). The theoretical maximum value of the colour index would be 600. Fruit colour was better in the upper tree parts than in the lower tree parts. Averaged for 1990 and 1991, the colour index was 350 and 528 respectively for

lower and upper tree halves. Fruit number was similar for both tree halves. Although tendencies were similar, the effects of the various treatments were more pronounced in the lower halves than in the upper halves (data not shown). Fruit colour per tree was highest at the lowest density (Table 28). At a given density, fruit colour increased going from 1:1-systems to 3:1-systems. The effect of tree height on fruit colour was small and could only be observed in 1991, when fruits of the highest trees were more coloured than fruits of lower trees.

During the last 4 years, fruit weight did not differ between lower and upper tree halves, and neither density nor arrangement influenced fruit weight. The lowest trees had on average 11 g heavier fruit weight than higher trees (Table 28). Partly, this was due to smaller crop load, since the effect of tree height was more pronounced when lower trees cropped less than higher trees.

Table 28. Colour index* and fruit weight.

	Colour index 1990 - 1992	Fruit weight 1989 - 1992		
Trees/ha				
2000	387c			162a
2667	361b			164a
4000	314a			164a
Rectangularity				
1:1	379c			163a
2:1	354b			164a
3:1	329a			162a
Height (m)	Colour index			
	1990	1991	1992	
1.50	341	351	357	171b
1.88	341	352	363	160a
2.25	326	389	366	158a
LSD	**	28	*	5

* colour index: see text p. 30.

** values do not differ significantly ($P = 0.05$).

Light interception was measured on a cloudy day in the middle of July 1992. A linear relationship was observed between light interception and increasing planting density or decreasing rectangularity (Table 29). Lower trees intercepted slightly less light than higher trees. Light interception was 4 % higher than in 1991. This was probably due to leaf development, since records were taken 3 weeks later in 1992 than in 1991. Light penetration within trees showed similar patterns to 1991 and was rather low for the lower and inner tree parts.

After harvest 1992, the upper tree parts of 1 tree per plot were harvested and dried. In addition, half of the root system was washed out on 16 trees (2 replicates, treatment 2000 1:1, 2000 3:1, 4000 1:1, and 4000 3:1, each with tree height 1.50 m and 2.25 m). The ratio of above-ground woody tissue (stem + shoots) to roots + rootstock varied between 0.5 and 1.5, with an average of 0.78. Any influence of treatment could not be detected. Total leaf area between 1983 and 1992 was estimated from measured leaf area per density in

Table 29. Light interception (I, %), 13 July 1992 (diffuse conditions).

Trees/ha	I	Rect.	I	Height (m)	I
2000	67	1:1	82	1.50	72
2667	73	2:1	74	1.88	75
4000	84	3:1	68	2.25	77
LSD	2		4		4

(P = 0.05).

several years. Missing values were estimated by linear interpolation between consecutive years. From these data and total fruit yield the total dry-matter production and distribution was estimated. Total dry matter increased linearly with density. On average (2889 trees/ha), 62, 35, and 16 ton/ha fruit, woody tissue (stem, shoots, rootstock, and roots), and leaf were produced between 1983 and 1992. Any influence of density, rectangularity, or tree height on dry-matter partitioning was absent. The average percentages of fruit, woody tissue, and leaves were 55 %, 31 %, and 14 %, respectively. Probably the percentage of woody tissue was slightly underestimated, because pruning wood was not taken into account. Besides, part of the root system (particularly finer roots) was lost at sampling, which is inherent in the method. In addition, the turnover rate of the root system was not measured.

Optimal cropping level of cordon trees - C.M.E. de Gendt

In the winter of 1989/1990 a trial was planted with cordons of Jonagold Schneica on M.27 rootstock. The planting distance was 1.50 x 0.45 m (14815 trees per ha). The aim of the trial was to establish the "optimal" cropping level (leaf/fruit ratio in number of leaves per fruit) of cordon trees. "Optimal" means a high, annual production of fruits with a mean diameter of 75 mm within grade class I, because these fruits are economically important.

Each year hand-thinning was carried out to obtain previously fixed cropping levels, ranging from 10 to 35 fruits per tree. At harvest, the leaf/fruit ratio was determined by counting all leaves and fruits per tree. The diameters were measured from 10 fruits per tree. The diameters were measured from 10 fruits per tree. After the 1992 harvest, 4 trees were used for determining dry-matter partitioning. The ground among the roots was washed away with water under high pressure (about 8 atm). The tree parts (fruits, leaves, stems, rootstock and roots) were dried separately in an oven to determine the dry weight.

Leaf/fruit ratio - C.M.E. de Gendt

Figure 1 shows the results of 2 growing seasons (1991 and 1992). In 1992, the fruit diameter was 8 mm larger at all leaf/fruit ratios than in 1991. This great difference can be explained by the exceptionally good weather in the months of May and June. In these months, temperatures were about 5 °C higher in 1992 than in 1991, and the global radiation was considerably higher, too. In May and June cell division takes place and this process proceeds faster at higher temperatures and higher global radiation. Apart from the weather, the fruit diameter also depends on the leaf/fruit ratio. The fruit diameter increased with increasing leaf/fruit ratio. In 1992, the fruit diameter was 77 mm with a leaf/fruit ratio of 15 and 84 mm with a leaf/fruit ratio of 30.

It doesn't often happen that fruits of triploid cultivars remain too small. More often the fruits become too large. Fruits with a diameter of more than

90 mm are not wanted, because prices are lower than those paid for smaller ones. For an average fruit diameter of 75 mm about 24 leaves were needed in 1991, against only 13 in the exceptional year of 1992.

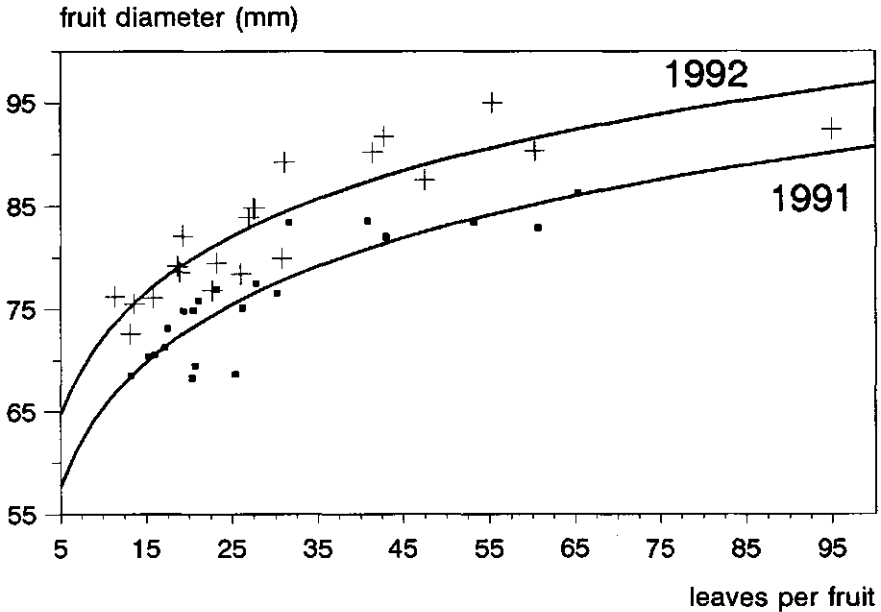


Figure 1. The relation between average fruit diameter (mm) just before harvest and the number of leaves per fruit of Jonagold Schneica in 1991 and 1992.

Dry matter partitioning in the tree - C.M.E. de Gendt

Figure 2 shows the dry-matter proportion of the total dry matter over the various tree parts from a tree with a high and a tree with a low cropping level. In both cases, a high percentage of the total dry matter was found in the fruits. This means that cordon trees are very efficient with their dry matter (a relatively high proportion was found in the fruits). The distribution of the dry matter depended very much on the cropping level of the tree. At a high cropping level a higher proportion of the total dry matter went into fruits than at low cropping levels, regardless of the part with normally goes to the stems and the roots. From the results obtained we can conclude that fruits are competing for dry matter with stems and roots. Dry matter in the stems is needed for good flower-bud formation and for tree development (very important in the early years). Dry matter in the roots is needed for the formation of new roots which are indispensable for the uptake of nutrients. (Water uptake can also take place through older roots).

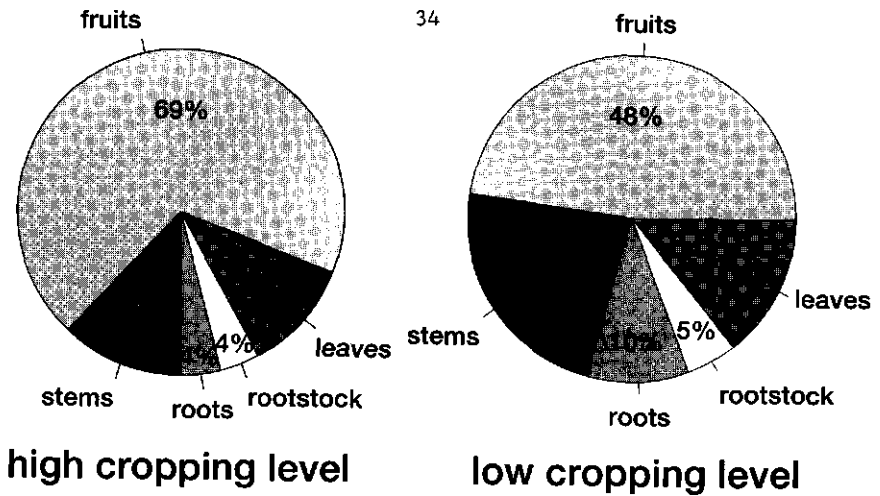


Figure 2. The dry-matter distribution of a cordon tree with a high cropping level (left) and a low cropping level (right) for Jonagold Schneica.

Alternate bearing - C.M.E. de Gendt

From other research it is known that there is a chance for alternate bearing when more than 60-70 % of the total dry matter is going to the fruits. In October 1992, it was observed that trees which produced many fruits for two years had less roots (about half) and poorly developed flower buds compared to trees producing lower fruit numbers. As compared to slender spindles, cordons form thinner stems and less roots. This means that cordons have less capacity to level out fluctuations in dry matter and are easier thrown off balance.

The total leaf area of a cordon tree was about 1 m²; the leaf area of one leaf was at least 20 cm². This means that one Jonagold cordon possessed about 480 leaves per tree. For a mean fruit diameter of 75 mm a leaf/fruit ratio of about 24 leaves per fruit is needed. From this we can conclude that the Jonagold cordon trees of our trial could yield 20 fruits (about 4 kg). Cordons are easily thrown off balance: 5 fruits more per tree (25 fruits per tree) resulted in a change of the leaf/fruit ratio from 24 to 19 leaves per fruit. With such a leaf/fruit ratio the fruits can only reach a diameter of 72 mm at a maximum.

The annual production per hectare of the Jonagold cordons was 9, 44 and 55 tonnes respectively for the period 1990-1992. In 1991, light interception of the planting system was 59 % and in 1992, 66 %. From these results we can conclude that the maximal production level has been reached, because the optimal light interception is about 70 %. If more light is intercepted, fruit colouring and flower-bud formation in the lower tree parts become negatively affected.

EVALUATION GROWTH REGULATORS

S.J. Wertheim and J.M.T. Balkhoven-Baart

Chemical thinning

In 1992 3 trials were carried out to improve the effectiveness of chemical thinning on Elstar.

In a trial in a commercial orchard at Nieuw en St.Joosland treatments with Amid Thin and benzyladenine (BA) mentioned in Table 30 were compared on 4-year-old Elstar trees on M.9. BA is a cytokinin and is not allowed for practical use. No thinning, hand-thinning and carbaryl (0.15 %) were included as standards.

Table 30. Treatments in chemical-thinning trial with Elstar at Nieuw en St.Joosland in 1992.

1.	Untreated
2.	Hand thinned
3.	0.15 % carbaryl at 12 mm fruitlet diameter older wood
4.	63 ppm NAAm* end of bloom + 0.025 % Luxan surfactant H
5.	50 ppm BA, 3 weeks after full bloom + 0.025 % Luxan surfactant H
6.	100 ppm BA, 3 weken after full bloom + 0.025 % Luxan surfactant H
7.	200 ppm BA, 3 weken after full bloom + 0.025 % Luxan surfactant H
8.	400 ppm BA, 3 weken after full bloom + 0.025 % Luxan surfactant H
9.	4 and 5
10.	4 and 6
11.	4 and 7
12.	4 and 8

* 63 ppm NAAm is 75 g Amid Thin/100 l water.

Full bloom on older wood was on 5 May. Amid Thin was sprayed on 14 May. The blossoming on the older wood had ended and on the 1-year-old twigs it was almost finished. Air temperature was about 35 °C. Relative Humidity (RH) was 40 %.

Table 31. Results chemical-thinning trial with Elstar at Nieuw en St.Joosland in 1992.

Treatments	Fruits/100 flower clusters at harvest			Kg/tree Total	Mean fruit weight (g) normal fruits
	Normal	Pygmy	Total		
1.	47 abc	2 a	50 abc	15.7	153
2.	47 abc	0 a	48 abc	15.0	159
3.	35 a	1 a	36 a	11.7	165
4.	51 bc	10 bc	61 cd	16.1	155
5.	49 bc	1 a	51 abc	16.2	152
6.	41 ab	3 a	43 ab	14.5	158
7.	35 a	1 a	36 a	13.5	166
8.	45 abc	3 a	47 abc	14.0	166
9.	42 ab	7 b	49 abc	16.8	153
10.	46 abc	8 b	54 bc	16.2	169
11.	57 c	14 c	71 d	17.8	156
12.	41 ab	10 bc	51 abc	13.0	150
					n.s.

Values in 1 column followed by the same letter(s) do not differ significantly (P = 0.05). n.s. = non significant.

Per ha about 1125 l water was sprayed. Despite the high temperature no leaf damage was seen the next day. Carbaryl was sprayed on 25 May at 12.2 mm average fruitlet diameter. Again temperature was high, about 30 °C. RH was 60 %. About 1500 l water per ha was sprayed. On the morning of 26 May, BA was applied at 30 °C and 60 % RH, but in the afternoon RH dropped to 30 %. Again, 1500 l water per ha was used.

The treated trees had on average 200 flower clusters. Fruit set was good with 200 fruits per 100 flower clusters. Natural June drop was severe. Hand thinning was not necessary. In all treatments pygmy fruits occurred next to normal size fruits. The pygmy fruits had an average fruit weight of about 70 g and were picked separately.

Amid Thin had a significant effect on promoting the occurrence of pygmy fruits (Table 31). None of the treatments thinned. Treatment 11 seemed to improve fruit set but this was caused by an increase in the number of pygmy fruits. There were no effects on fruit size of normal fruits. These disappointing results on thinning may have been caused by the severe natural June drop.

Table 32. Results in chemical-thinning trial with Elstar at Numansdorp in 1992.

Treatments	Fruits/100 flower clusters (hand-thinned fruits included)			Kg/tree total	Fruit- weight normal fruits (g)	
	Normal	Pygmy	Total			
1. Hand-thinned	111 b	59*	0 a	111	23.2	152 ab
2. 0.15 % carbaryl	76 ab		0 a	76	31.4	154 ab
3. Untreated	102 ab		3 ab	105	34.1	130 a
4. Untreated + s **	109 b	72*	0 a	109	30.8	164 ab
5. Untreated + o ***	96 ab	59*	0 a	96	26.4	169 b
6. 33 ppm NAAM	99 ab		5 ab	104	36.6	141 ab
7. 33 ppm NAAM + s	98 ab		10 ab	108	35.4	143 ab
8. 33 ppm NAAM + o	80 ab		20 abc	100	31.0	139 ab
9. 67 ppm NAAM	87 ab		19 abc	106	33.3	148 ab
10. 67 ppm NAAM + s	89 ab		22 abc	111	35.0	143 ab
11. 67 ppm NAAM + o	78 ab		24 abc	102	29.9	138 ab
12. 100 ppm NAAM	77 ab		23 abc	100	32.4	150 ab
13. 100 ppm NAAM + s	71 ab		35 bcd	106	29.7	142 ab
14. 100 ppm NAAM + o	84 ab		30 abcd	113	34.6	143 ab
15. 2x 67 ppm NAAM + s	71 ab		45 cd	116	33.6	154 ab
16. 3x 67 ppm NAAM + s	60 a		55 d	115	28.9	143 ab
			n. s.			

* Fruits per 100 flower clusters after hand-thinning.

** s = 0,025 % Luxan surfactant H.

*** o = 0,1 % Luxan mineral oil H.

n.s. = non significant

Values in 1 column followed by the same letter do not differ significantly (P = 0.05).

A second trial was carried out at the research garden in Numansdorp. To improve the effectiveness of Amid Thin (NAAm) in chemical thinning, addition of a mineral oil, a surfactant or the use of higher concentrations and repeated sprays were included (Table 32). Amid Thin was used in doses of 33, 67 and 100 ppm NAAm, which corresponds with 39, 80 and 119 g Amid Thin/100 l water respectively.

The experimental trees were 7-year-old Elstar with about 270 flower clusters per tree. Amid Thin was sprayed on 15 May at 17 °C and 80 % RH. Several hours after spraying the temperature reached 30 °C in the weather house. The repeated treatments (15 and 16) were sprayed on 18 and 21 May at 12 °C and 16 °C and 80 % and 92 % RH respectively. After these sprays were made temperatures rose to 23 °C and 27 °C in the weather house. Fruitlet diameter at the second Amid-Thin spray was 6.7 mm and at the third 10.0 mm. On 25 May carbaryl was sprayed at an average fruitlet diameter on old wood of 13.7 mm at 16 °C and 90 % RH. Table 32 shows the results.

Fruit set was good. Natural June drop was moderate. In the hand-thinning treatment over 100 fruits per tree were thinned. Since no thinning effect was visible in treatments 4 and 5, these were hand thinned. Because of the hand-thinning fruit weight was better in treatments 1, 4 and 5.

Table 33. Results in chemical-thinning trial with Elstar at Zeewolde in 1992.

Treatments	Fruits/100 flower clusters (hand-thinned fruits included)			Kg/tree normal fruits	Fruit- weight normal fruits (g)
	Normal	Pygmy	Total		
1. Untreated	203	3 a	206	38.0	143
2. Hand thinned	182 133*	1 a	183	31.0	164
3. 1x NAAm (N)	158	2 a	161	35.1	153
4. 2x NAAm	152	13 ab	165	32.6	160
5. 3x NAAm	143	24 c	167	29.2	154
6. 1x carbaryl (C)	167	1 a	168	36.7	166
7. 2x carbaryl	154	0 a	154	34.3	156
8. 3x carbaryl	152	0 a	153	32.6	172
9. 1x N + 1x C	133	1 a	133	33.8	178
10. 1x N + 2x C	126	3 a	128	29.5	169
11. 1x N + 3x C	119	3 a	122	31.6	189
12. 2x N + 1x C	151	8 a	158	31.7	170
13. 2x N + 2x C	136	9 a	145	31.6	170
14. 2x N + 3x C	117	10 a	126	29.1	181
15. 3x N + 1x C	128	20 bc	148	29.9	160
16. 3x N + 2x C	141	25 c	167	32.6	159
17. 3x N + 3x C	134	25 c	159	29.1	167
	n.s.		n.s.		n.s.

* Fruits per 100 flower clusters after hand thinning.

n.s. = non significant

Values in 1 column followed by the same letter do not differ significantly (P = 0.05).

In this trial pygmy fruits occurred, too. The fruit weight of the pygmy fruits varied between 30 g and 60 g. Amid Thin promoted the occurrence of pygmy fruits. The higher the doses or the more treatments used, the higher the number of pygmy fruits. Three sprays of Amid Thin (treatment 16) resulted in 157 normal fruits and 155 pygmy fruits. Adding a surfactant or a mineral oil had no effect, either on thinning or on pygmy fruits. None of the treatments caused thinning. Only by hand thinning was the number of fruits per 100 flower clusters lower and fruit size improved.

A third trial was carried out at the research garden at Zeewolde. Repeated sprays of Amid Thin (75 g/100 l) and carbaryl (150 g/100 l) were studied. The treatments are given in Table 33. The trial was made with mature Elstar trees with about 100 flower clusters per tree. Amid Thin was sprayed on 14, 18 and 20 May at 22 °C, 13.5 °C and 22 °C and 55 %, 85 % and 40 % RH respectively. After the sprays temperatures rose to between 25 % and 31 °C in the weather house.

In the hand-thinned treatment about 80 fruits per tree were removed. None of the chemical treatments caused significant thinning. Values were not significantly different because of large variation. As in the 2 former experiments pygmy fruits were found. The number of these fruits was lower in this trial, but was also higher after Amid-Thin sprays. Repeated sprays gave most pygmy fruits. No effect was found on fruit size of normal fruits.

Pygmy fruits

The occurrence of pygmy fruits with Elstar may have been promoted by the high temperatures at and after the Amid-Thin sprays. Also the stage for Amid-Thin application may have been reached sooner than 14 days after full bloom with the rapid growth of the fruits in 1992. The second and third application of the repeated sprays may have been applied so late, that they resulted in the occurrence of pygmy fruits. In the trial at Numansdorp the effect was most pronounced. Here, the third Amid-Thin spray was applied at 10 mm average fruit diameter. In Italy, 7 mm fruit diameter is held as a maximum threshold for Amid-Thin sprays.

The reason for the pygmy fruits is unknown. It has been found that pygmy fruits contain a high level of ethylene. Ethylene is a natural growth retardant in the plant. Possibly, Amid Thin promoted the level of ethylene in some of the fruits to damaging levels. Why such fruits did not drop, is not clear. Amid Thin is an auxin, that normally prevents the abscission of plant parts. Maybe there was an excess amount of Amid Thin in the fruits that counteracted the drop-promoting effect of ethylene. Whatever the cause, Amid Thin is risky for Elstar.

TREE SHAPE AND PRUNING

J.M.T. Balkhoven-Baart

Root pruning

In spring 1992 a root-pruning trial was carried out, in which effects of root pruning and deblossoming were studied on vegetative growth, fruit size and fruit quality. Roots were pruned with a sharpened subsoiler mounted vertically on a tool bar and offset to one side of a tractor.

Two-year-old Delcorf apple trees on M.9 were root pruned in the dormant stage (18 March) or at full bloom (11 May). The experimental trees were planted in single rows at 3.0 x 1.25 m. The cuts were made on 2 sides of the trees at 25 cm distance from the trunk to a depth of 40 cm. By deblossoming half of the trees at flowering time, frost damage was imitated.

Trees were fertigated from April onwards.

Table 34. Results 1992 root-pruning trial 92.0.35.

Treat- ment	Deblos- soming	Flower buds	Kg/tree	Fruits/ tree	Mean fruit weight (g)	Grading index* fruit size
1. Control	-	106	7.5 a	35	213 a	284
2. Control	+	106				
3. March	-	106	7.5 a	37	205 a	273
4. March	+	107				
5. May	-	112	7.1 a	34	208 a	276
6. May	+	108		n.s.		n.s.

* Grading index size: Sum of weight percentages: (1x % kg 60-70 mm) + (2x % kg 70-80) + (3x % kg 80-90) + (4x % kg > 90).

n.s. = non significant.

Values in one column followed by the same letter do not differ significantly (P = 0.05).

No significant differences occurred in fruit set, June drop, production or fruit size between control and root-pruning treatments (Table 34).

Table 35. Results 1992 root-pruning trial 92.0.35.

Treat- ment*	Increase in trunk circumference 1992 (cm)	Number of shoots/ tree	Total growth/tree ----- (m)	(%)	Average shoot length (cm)
1.	1.9	46	13.6 cd	92	30
2.	2.5	51	14.8 d	100	29
3.	1.3	33	8.5 a	58	25
4.	2.2	45	12.2 bc	82	27
5.	1.4	36	9.8 a	66	27
6.	2.3	45	11.7 b	79	27

* See Table 34. Values in one column followed by the same letter(s) do not differ significantly (P = 0.05).

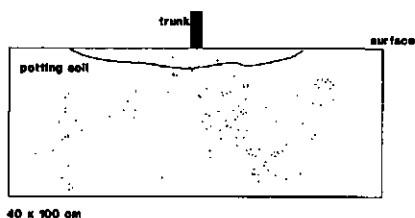
In Table 35 the measurements for vegetative growth are mentioned. Deblossoming gave only a little extra growth (8 %). Root pruning on non-fruiting trees gave about 18-19 % growth reduction compared to control trees. Root pruning on fruit-bearing trees gave more growth reduction (28-37 %). In particular the number of lateral shoots per tree and their average length were reduced.

Root-development studies

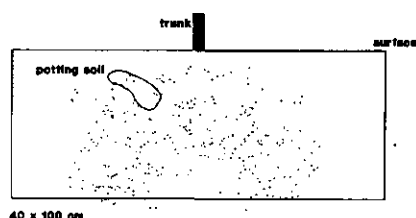
In the trial with Delcorf described above, root-development studies were carried out. After root pruning on 11 May, plexiglass windows (1.00 x 0.50 m)

were placed in the cut. The windows were placed at 4 trees with and at 4 trees without deblossoming, both at the east and the west sides of the trees. At 4 times during the season (1 June, 26 June, 9 July and 21 September) soil was removed on the grass strip side of the windows. Behind the windows root growth was visible. On plastic covers placed over the window new roots were indicated as dots with a pencil. On 21 September roots were growing along the windows and were drawn completely (Figure 3).

White roots on 9 July 1992

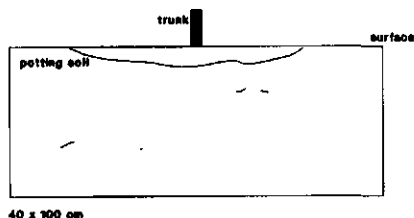


Tree with fruits

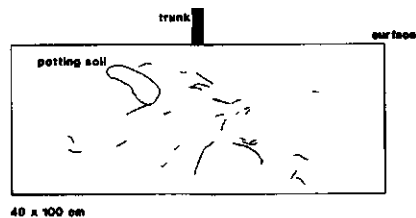


Tree without fruits

White roots on 21 September 1992



Tree with fruits



Tree without fruits

Figure 3. Root-development studies with Delcorf on M.9 in trial 92.0.35. White roots at 9 July and 21 September with deblossomed and non-deblossomed trees after root pruning on 11 May.

During 10 days after root pruning no new root growth occurred. On 1 June, new root growth was visible. During the season there was more root growth on the deblossomed trees. This stronger root development is probably the cause of the more vigorous vegetative growth (Table 35). Fruit-bearing trees apparently used more energy for fruit development growth than for vegetative development and root growth. After harvest (1st and 2nd pick at 12 and 18 August respectively) little root development took place. There were no visible differences in root growth between the east and west sides of the tree.

EVALUATION TOP FRUIT CULTIVARS

CULTIVAR TESTING WITH APPLE

P.D. Goddrie and H. Kemp

Cultivar trials in Wilhelminadorp

In the spring of 1992, 36 new apple cultivars were planted, of which 15 are (or should be) resistant to one or more fungal disease. Amongst the 36 new cultivars and selections there are 7 disease-resistant cultivars from the former D.D.R. (the so-called Re-cultivars like Reglindis, Rene, and so on), 7 cultivars from Sweden, 5 disease-resistant cultivars from the former Czechoslovakia like Vanda and Rosana, 6 cultivars from Japan, and 5 Dutch CPRO-selections. As with all other cultivars under trial, these new ones will also be tested on rootstock M.9.

In the testing period 1988-1992 it appeared that the picking time of Braeburn is 2 to 3 weeks later than that of Jonagold. In years with favourable weather conditions an acceptable eating quality can be obtained. It remains doubtful, however, whether Braeburn is a suitable cultivar for growing under the Dutch conditions. From spring 1994 onwards attention will be paid to several selections and mutations of Braeburn.

At the end of 1992 testing of Elise was terminated. In 1992 it was confirmed that the occurrence of bitter pit and black spots (lenticel-spot) on fruits of this cultivar is a problem which occurs mainly on young(er) trees. Because of these problems it is advised that care should be taken with planting of Elise.

Table 36. The fruit size of some Gala mutations in 1992. (Figures are percentages of the graded kg).

Size	Mitchgla	Tenroy	Regal Prince
< 60 mm	1.7	0.8	0
60-65 mm	4.4	6.3	0
65-70 mm	19.9	20.1	3.4
70-80 mm	69.9	9.1	53.6
> 80 mm	4.1	3.8	43.0

Fruit size grading in 1992 of the Gala mutations Mitchgla, Tenroy, and Regal Prince proved that fruits of Regal Prince are bigger than those of Mitchgla and Tenroy. The grading results are mentioned in Table 36. Also average fruit weights measured in 1992 and previous years indicated that the size of the fruits of Regal Prince is bigger than that of Mitchgla and Tenroy.

In Table 37 some trial results are given of the German apple cultivars Pikant, Pilot, Pinova and Piros, planted in the spring of 1989. These cultivars were obtained from crosses in which Undine, Carola, Clivia, Helios, Apollo and Golden Delicious were used as parents. Although often said, these 4 cultivars are not disease-resistant. As can be seen in Table 37, Piros is less productive compared to the other ones. The average fruit size of Pilot was smaller than that of the others. All cultivars were quite red-blushed; Pilot had the highest amount of blush. The fruit flesh of all cultivars is

firm, resulting in a rather long shelf life. In general, eating quality was moderate, but certainly acceptable. The 1992 results confirm those of previous years.

Table 37. Some characteristics of 4 German apple cultivars, planted in the spring of 1989.

	Pikant	Pilot	Pinova	Piros
Picking time	early Sept.	3rd week Oct.	3rd week Oct.	mid-Aug.
Kg/tree 1989-1992	30	31	46	14
% fruits:				
< 70 mm	1	14	6	6
70-80 mm	7	67	40	47
> 80 mm	92	19	54	47
% fruits with:				
0-20 % blush	35	3	27	30
21-50 % blush	44	49	50	33
51-75 % blush	12	38	21	29
> 75 % blush	9	10	2	8
Firmness	firm	firm	rather firm	firm

Since spring 1990 all new-planted cultivars are planted in plots with and plots without application of fungicides. In July 1992 observations were carried out on the presence of symptoms of scab (*Venturia inaequalis*) on leaves and fruits and of mildew (*Podosphaera leucotricha*) on leaves and shoots of 118 cultivars and selections in the plot where no fungicides were used since spring 1990. In Table 38 results concerning the presence of scab and mildew on a number of cultivars and selections is given. It appeared that the current cultivars grown in The Netherlands vary from rather susceptible to very susceptible to scab and sometimes also to mildew. Rafzubin was very susceptible to scab and mildew; Elise and Delcorf were very susceptible to scab, but had a low susceptibility to mildew. Gala (Regal Prince), Rode Boskoop Schmitz Hübsch, Elstar, Cox's Orange Pippin, and Karmijn de Sonnaville were rather susceptible to both diseases. Golden Delicious and Fiesta were very susceptible to scab and rather susceptible to mildew. A favourable exception is Discovery which had very few symptoms of scab and mildew after 3 years without application of fungicides. In general, the so-called resistant cultivars and selections remained (almost) free of scab, but appeared to be more or less susceptible to mildew, such as Priscilla, Sir Prize and Florina. The CPRO selections 78039-18 and 78039-27, both from crosses of Elstar x Prima, were practically free of scab and mildew symptoms. The interesting new CPRO selection 78038-9 from a Elstar x Priscilla cross appeared to be rather susceptible to mildew. Concerning fruit appearance, fruit size, and eating quality, this selection can be considered as an interesting new scab-resistant selection. The (too) low level of susceptibility to scab and mildew was the reason that a number of cultivars and selections were removed from the plot without use of fungicides as being sufficiently examined.

Table 38. The level of presence of scab and mildew on some apple cultivars and selections on 28 July 1992 (1 = no attack, 9 = very heavy attack).

	Scab		Mildew
	on leaves	on fruits	on leaves and shoots
Discovery	1.9	2.8	1.3
Alkmene	5.1	4.5	2.9
Rode Boskoop S.H.	3.0	4.7	4.3
Elstar	6.5	5.0	5.5
Gala (Regal Prince)	6.3	5.5	4.0
Cox's Orange Pippin	6.0	5.5	6.0
Elise	8.0	7.0	1.0
Fiesta	7.5	7.0	3.8
Delcorf	8.3	7.7	1.3
Golden Delicious	8.1	7.8	2.6
Rafzubin	8.8	8.3	7.0
Karmijn de Sonnaville	7.8	5.0	5.5
Prima*	1.0	1.0	1.0
Priscilla*	2.5	1.0	4.0
Sir Prize*	1.5	1.1	4.3
Florina*	2.0	1.0	5.8
CPRO 78039-18*	1.1	1.0	1.1
CPRO 78039-27*	2.7	1.1	1.6
CPRO 78038-9*	1.7	1.1	4.6
X3177*	1.0	1.0	1.0
X4972*	1.0	1.0	1.0
TSR 29T219*	2.3	1.3	1.0
Co-op 27*	1.0	1.0	2.8
Co-op 28*	1.0	1.0	1.8
Co-op 29*	1.3	1.0	7.5
Co-op 30*	1.0	1.0	2.5
Co-op 31*	1.0	1.0	1.8

* = cultivar/selection belongs to the group of resistant cultivars.

In the winter season 1992/1993 9 taste experiments were carried out. Judging the results described hereafter, it must be realized that all the tested cultivars and selections were stored together in cool storage at 3 °C from the picking date onwards. Such storage conditions are far from ideal for the cultivars involved. For the taste experiments people from the research station were used as taste panel members. This means that the (eating) quality of the cultivars is critically examined. From earlier experiments it is known that, in general, the appreciation of the eating quality by "real" consumers is somewhat higher. Most important, however, are the differences in appreciation between the cultivars.

In 3 taste experiments, done on 19 November, 12 January, and 8 March, the eating quality of 4 Gala fruit colour mutations was examined. The results are given in Table 39. The eating quality of the Gala mutations was rated almost as high as that of standard Golden Delicious. Quite often the taste of the Gala types was described as sweet, insipid and watery.

In 2 taste experiments, respectively on 1 and 17 March, the eating quality of Pilot, Pinova, Pikant and Braeburn was compared to that of the standard cultivars Elise, Elstar and Golden Delicious. In the test of 1 March the taste

Table 39. The eating quality of Golden Delicious and colour mutations of Gala. (1 = very bad taste; 9 = excellent taste).

	Average score on		
	19 November	12 January	8 March
Golden Delicious	6.5 a	6.2 a	5.8 a
Tenroy	5.7 b	5.9 a	5.7 a
Regal Prince	5.4 b	6.1 a	---
Mitchgla	---	---	5.6 a
Galagored	---	---	5.8 a

Figures in 1 column followed by the same letter do not differ significantly ($P = 0.05$).

of Pilot, Pinova, Braeburn and Elise (scores respectively 6.1, 5.9, 5.9, 6.1) did not differ significantly. Pikant (score 4.2) had a significantly poorer eating quality. In the test of 17 March Elstar (score 6.5) rated significantly better than Pilot, Pinova and Braeburn (scores respectively 5.9, 5.5, 5.7) which were not significantly different. Golden Delicious was significantly worse than the other cultivars (score 4.4). In the test of 1 March, many remarks were made on the firmness of Pilot and Braeburn. Measurements of the firmness of the fruits used for the taste experiment by using a penetrometer indicated that Pilot and Braeburn could be considered as firm cultivars (firmness respectively 7.0 and 6.0 kg/cm²). The firmness of Pilot and Pikant on the testing date was respectively 5.6 and 5.3 kg/cm². In particular Pinova was quite often considered as (too) soft. Probably the testing date was chosen too late for these 2 cultivars. The lowest firmness figure was found with Elise (5.2 kg/cm²). In spite of that the eating quality was found to be acceptable.

On 3 December the eating quality of some disease-resistant cultivars was compared to that of standard Golden Delicious. The results are given in Table 40. Probably the testing date was too late for TSR 29T219 and X4972, because many negative remarks on the firmness of these cultivars were made. The external condition, however, was still perfect.

On 29 January a first taste experiment was done with the disease-resistant German cultivars Rene, Relinda and Rewena.

They were compared with the American selection Co-op 29 and standard Jonagold. In this test the eating quality of Co-op 29 and Jonagold (both scored 6.2) was significantly better than that of Rene and Rewena which did not differ significantly (scores respectively 5.2 and 4.7) and the significantly lowest rated Relinda (score 3.6). Fruits of Relinda were considered as firm and acid. Judging these results it must be realized that

Table 40. The eating quality of some resistant apple cultivars and Golden Delicious on 3 December (1 = very bad taste; 9 = excellent taste).

	Average score
Golden Delicious	6.7 a
CPRO 78038-9	6.2 ab
X4972	5.6 bc
T 18	5.3 cd
TSR 29T219	4.9 de
X3177	4.5 e

Figures followed by the same letter(s) do not differ significantly ($P = 0.05$).

the fruits of the German cultivars came from trees in their first growing season. It could therefore be possible that picking of the fruits was not done on the proper date, causing a negative influence on the eating quality.

In 2 taste experiments, on 22 January and 12 February respectively, the eating quality of 4 American resistant selections was compared with that of the standard cultivars Elstar, Jonagold and Golden Delicious. The results are given in Table 41.

Table 41. The eating quality of American resistant apple selections in comparison to Elstar, Jonagold and Golden Delicious (1 = very bad taste; 9 = excellent taste).

	Average score on:	
	22 January	12 February
Jonagold	6.5 a	-
Co-op 29	6.1 a	5.8 a
Golden Delicious	6.0 a	-
Co-op 31	6.0 a	5.3 ab
Co-op 30	5.9 a	5.8 a
Co-op 27	4.9 b	4.8 b
Elstar	-	5.0 b

Figures in 1 column followed by the same letter(s) do not differ significantly ($P = 0.05$).

It appeared from these 2 taste experiments that Co-op 29 is an interesting cultivar as far as eating quality is concerned. Also in the taste experiment with German cultivars described above, Co-op 29 got a positive appreciation. Co-op 29 is a cultivar with rather firm fruits with rather high acidity. Fruit skin is yellow and mostly with some netted russetting. As mentioned in Table 38 no symptoms of scab were found on fruits in the plot where no fungicides are applied. Unfortunately, Co-op 29 is rather susceptible to mildew. It may be, therefore, that Co-op 30 is at least as interesting as Co-op 29. In taste experiments the eating quality was not far behind that of Co-op 29, while this selection appeared to be less susceptible to mildew. Also Co-op 30 has firm fruits with a somewhat lower acidity than fruits of Co-op 29. The fruits of Co-op 30 are attractive, having a yellow ground colour with a rather dark red over colour. In the United States this apple was named Enterprise. The unexpected low appreciation for Elstar in this experiment was due to the fact that the fruits were kept in storage under Ultra Low Oxygen conditions till 2 days before the taste experiment. That period is too short to reach an acceptable eating quality after such storage.

In the next few years the number of resistant cultivars in the cultivar trials will increase. It is expected that within a few years cultivars will be available with which the number of sprays to control scab and mildew can be reduced considerably. It seems that with cultivars like Co-op 29, Co-op 30, and probably also CPRO 78038-9, a small step can be made in the direction of growing fruit with less use of fungicides. The quality, both internal and external, of these 3 selections is considerably better than that of the "old" resistant cultivars Prima, Priscilla, and Florina and probably also better than the CPRO selections 78039-18 and 78039-27 tested up to now. More research in future has to confirm the results obtained so far with the Co-op selections. In the meantime trees of the next series of Co-op selections

(32 to 38) are being raised. They will be planted in the spring of 1994. One of these, Co-op 38, was named Goldrush.

At the end of the 1992 growing season research on 19 apple cultivars and selections was terminated. There follow some remarks on those cultivars (in brackets the year of planting and country of origin).

CPRO 78038-39	(1988, NLD): russetting and cracking; moderate eating quality; insufficient productivity
Delgorou	(1989, FRA): rather low eating quality; very greasy fruits
Deljeni	(1986, FRA): insufficient productivity; moderate eating quality; somewhat susceptible to skin browning
Delkistar	(1987, FRA): insufficient productivity; russeted fruits; susceptible to fruit tree canker
Elan Van Doorn	(1990, NLD): sufficiently examined; attractive fruit colour mutation of Elan
Elise	(1982, NLD): sufficiently examined; included in Rassenlijst Fruit 1992 (Cultivar List Fruit Crops 1992)
Jonagold Crowngold	(1987, GBR): sufficiently examined; included in Rassenlijst Fruit 1992 (Cultivar List Fruit Crops 1992)
Jonagold LA12	(1987, GBR): no improvement on standard Jonagold
Majjel	(1990, NLD): mutation of Elstar with upright growth; branches tear easily; no improvement on other Elstar mutations
Natsumidori	(1989, JPN): poor eating quality; sweet taste
Newaphough (Newgold)	(1989, USA): susceptible to bitter pit, scald and mouldy cores
Paasster	(1988, NLD): insufficient productivity; moderate eating quality with unpleasant flavour; susceptible to soft scald and scald
Schotsmans	(1988, BEL): moderate eating quality; insipid; susceptible to soft scald; identical to CPRO 5544-220
Septer	(1988, NLD): moderate eating quality; susceptible to soft scald
Shamrock	(1987, CAN): very moderate taste with "strange" flavour
Sommerregent	(1987, DLD): low productivity; moderate eating quality; susceptible to fruit tree canker and mouldy cores
T 18	(1989, FRA): moderate eating quality; russetting
TSR 29T219	(1989, USA): moderate eating quality; susceptible to bitter pit and softening; rather much russetting
Yookou	(1989, JPN): "grey" apple; sweet insipid taste; rather much russetting

Cultivar testing in regional experimental orchards

At the end of 1992 the cultivar trial planted in the spring of 1988 in 4 regional experimental orchards was terminated. In 1992 observations were only made on Rafzubin, Fiesta, Elise and the standard cultivars Karmijn de Sonnaville and Elstar. Some results from this trial are given in Table 42.

Table 42. Some results from cultivar trial 88.0.5. Figures are means of 4 sites.

Cultivar	Kg/tree 1988-1992	Average fruit weight 1988-1992 (g)	Tree volume spring 1992 (m ³)
Rafzubin	46.0	133	0.83
Elise	59.3	213	0.61
Fiesta	41.0	186	0.58
Karmijn de Sonnaville	41.3	219	0.93
Elstar	55.8	167	0.84

In spite of high yields the size of Elise fruits was big. Fruits of Rafzubin are considerably smaller, which was also apparent from fruit size gradings. Trial results as well as other information resulted in placing the cultivars Rafzubin, Elise and Fiesta as new cultivars worth trying on a limited scale in the Dutch Cultivar List for Fruit Crops 1992.

Clone testing in Wilhelminadorp

Jonagold

At the end of 1992 testing of 38 colour mutations of Jonagold planted in the autumn of 1987 was terminated. Because only 4 trees of each clone were planted only fruit colour could be observed. Tree vigour, tree habit, productivity, picking time, storability and eating quality were not examined. For reliable observations on those characteristics replicated trials on more sites are required. Results obtained with the 38 mutations are summarized in Table 43.

In 1993 40 mutations planted in the 1989-1992 period will be examined. Amongst these there are again a number of mutations which hardly differ from each other or from standard Jonagold with respect to fruit colour.

Research on the stability of fruit skin colour in successive generations of Novajo and Crowngold indicated that Novajo can be considered as a stable Jonagold mutation. Crowngold seems to be somewhat less stable. Compared to 1991 somewhat less stability was found, which is, however, not disquieting.

Table 43. Classification of 38 colour mutations of Jonagold with respect to amount and type of blush.

Type	Mutation	Remarks
Standard types; yellowish-green ground colour with some orange/red blush	2291 T*	= standard
	2381 T*	= standard
	Nicobel (-2381 T)*	
	Bruygoms	
	Princen	
	van 't Anker	
	Goldpurpur	
	76-25-9	
	LA 12	
	van Ingen	
	Hakkers	
	Looyen	
	Daliguy	
Bright red blush with stripes and/or chimaeras on yellowish-green ground colour; more blush than standard Jonagold	van Leur	broad chimaeras
	van der Borgh	
	Wilmuta*	
	New Jonagold	many broad chimaeras
	Maatschap I	
	Daamen I	
Even, bright red blush on yellowish-green ground colour; more blush than standard Jonagold	Jonabel*	
	Jonakap*	
	King Jonagold*	
	Schneica*	
	Highwood*	slightly striped as standard Jonagold
	Crowngold*	slightly striped as standard Jonagold
	Peters	
Bright to dark red on yellowish-green ground colour; less yellowish-green colour than previous groups	van de Rijdt	
	Decosta*	
	van Helden	rather striped
	de Jager II	
	Novajo*	
Dark red with little or no yellowish-green ground colour	Maatschap II	
	Jonagored*	
	Jomured*	
	Rubinstar*	some tendency to brownish-red blush
	Jacobs I	
	Jonaveld*	
Brownish-red blush on yellowish-green ground colour	Nijskens	

* mutation is mentioned in the Cultivar List for Fruit Crops 1992.

Elstar

In the spring of 1988 a replicated trial (10 x 2 trees) was started in which 9 colour mutations of Elstar were tested. Some results of this trial, which was terminated at the end of 1992, are given in Table 44.

Table 44. Some trial results obtained with colour mutations of Elstar (88.0.13).

Type	Tree volume (m ³) end 1992	Kg/tree 1989- 1992	Kg/m ³ tree volume end 1992	Average fruit weight (g) 1989 - 1992	% fruits with > 33 % red blush 1992	% fruits > 70 mm 1990 + 1992
PFW I	0.92 a	48.6 a	53.7 b	180 a	81 b	78.6 ab
v.d.Zalm I	0.84 a	49.0 a	61.2 ab	181 a	80 b	78.9 a
v.Vliet	0.84 a	50.0 a	61.1 ab	178 ab	84 b	77.9 ab
Elshof (I)	0.82 a	51.3 a	67.0 a	172 bc	83 b	75.5 ab
Rietveld I	0.85 a	50.8 a	62.6 ab	175 abc	70 c	77.6 ab
Belders	0.88 a	49.2 a	56.2 ab	177 ab	97 a	77.5 ab
v.Kempen I*	0.69 b	42.5 b	65.8 ab	171 bc	84 b	74.9 ab
v.Kempen II*	0.67 b	41.4 b	65.2 ab	170 c	84 b	75.5 ab
Red Elstar I	0.88 a	48.0 a	56.5 ab	175 abc	79 b	77.9 ab
Red Elstar II	0.89 a	50.7 a	58.9 ab	180 a	82 b	78.8 a
Standard	0.87 a	48.8 a	59.7 ab	171 bc	71 c	73.6 b

* = not virus-free.

Figures in 1 column followed by the same letter(s) do not differ significantly ($P = 0.05$).

As is shown in Table 44 non virus-free mutations have smaller trees and less productivity (expressed in kg per tree) than virus-free mutations. There are no differences in productivity between non virus-free mutations and standard Elstar when yield is expressed in kg per m³ tree volume. Differences in fruit size, based on the average fruit weight during the testing period, are rather small. This is also true for the percentage of fruits > 70 mm. Except Rietveld, all mutations in this trial have a significantly higher percentage of fruits with more than 30 % red blush. Rietveld appeared to be identical to standard Elstar. The type Belders had significantly more red blush than the other mutations. Fruits of Belders were dark red striped and not attractive. A considerable amount of reverse to standard Elstar was found in type v.d.Zalm I.

Summarizing the results of this trial it can be concluded that none of the tested mutations can be considered as a real improvement on the mutations Red Elstar and Elshof, which are placed and recommended in the Cultivar List for Fruit Crops 1992.

At the end of 1992 research on 8 other mutations of Elstar was also terminated. Of these mutations only 4 trees of each were planted. Therefore, only observations on fruit appearance could be made. Some characteristics of these mutations are given in Table 45.

The mutation Leegwater had a bushy upright habit. Neither this mutation nor any one of the others mentioned in Table 45 can be considered as a real improvement of the current Elstar mutations.

Table 45. Characteristics of 8 colour mutations of Elstar (88.0.13a).

Mutation	Skin colour	Chimaeras	Reverse
van der Bliet	bright red	some	very few
Elshof II	bright to dark red	some	none
van der Borgh	bright red	some	very few
Melsen I	faded bright red	none	none
Melsen II	faded bright to some- what dark red	some	none
van der Grift	very dark red	some	none
Leeewater	bright red	some	none
Hermens	bright red	some	very few

Presently another 35 mutations of Elstar, planted in the 1989-1992 period, are being tested. In this series there are mutations which do not really seem to differ from standard Elstar and which very much resemble each other.

After picking the Elstar mutations in autumn 1992 all 55 mutations (= including standard Elstar) were examined for attractiveness by people of the research station and extension service. In general, mutations with a type of blush similar to that of standard Elstar but with a higher amount of blush were rated highest. With those mutations replicated trials are intended.

Table 46. Results obtained with colour mutations of Cox's Orange Pippin, planted in the spring of 1991 (91.0.2).

Mutation	Kg/tree	Average fruit weight (g)
	1992	1992
T 12 (standard)	6.6	196
Zwanenburg	8.9*	192*
van Vliet-4	7.3	210
Steyn	7.2	187
T 1088	7.0	208
van der Rijdt	6.5	211
Kummer B 396	6.5	169
Roelse	6.3	213
Queen Cox B 293	6.2	216
in 't Veld	5.7	209
Vroemen	5.4	183
van Vliet M.	5.1	197
van der Ploeg	4.9	198
Queen Cox EMLA	4.8	219
Buysens	4.7	191
Heldens	4.3	226
Flikweert	4.2	228
de Bruyn	4.2	194
Crimson Cox	3.7	191
Korallo	3.2	209
van Vliet-2	0.6	274

* = planted as 2-year-old trees.

Research on the stability of fruit colour on successive generations of Red Elstar, Elshof, and Elstar PFW I confirmed the 1991 results. Reverse in fruit colour can easily occur in Red Elstar and to a far lesser extent in Elshof and PFW I.

Cox's Orange Pippin

In the spring of 1991 a trial was planted in which 15 Dutch fruit colour mutations of Cox's Orange Pippin, found in commercial orchards, are being tested. These mutations are compared with better known Cox-types, such as T 12, Korrallo, Kummer and Queen Cox. The first results, obtained in 1992, are given in Table 46. No reliable conclusions can yet be drawn.

In the spring of 1992 3 trials were planted in which 10 clones of Queen Cox (9 from Great Britain, 1 from The Netherlands) are compared. Five of those clones are supposed to be self-fertile. First results are expected in 1993.

Clone testing in regional experimental orchards

Elstar

In the spring of 1987 a trial was planted in 4 regional experimental orchards in which 2 colour mutations of Elstar were compared with standard Elstar. Some results of that trial are given in Table 47.

Table 47. Results clone testing with Elstar (87.0.10).

Clone	Kg/tree 1988- 1992*	Average fruit weight (g) 1988- 1992*	% fruits in 1992 with**					% of the yield in 1st pick*
			0-10 % blush	11-33 % blush	34-50 % blush	51-75 % blush	76-100 % blush	
Standard	81.5	162	2.2	7.4	36.1	41.1	13.4	71
Elshof	85.5	161	1.3	3.6	26.5	43.1	25.7	78
Red Elstar	84.8	165	1.4	5.9	29.9	41.7	21.1	77

* Average figures of 4 experimental orchards.

** Average figures of 2 experimental orchards.

In Table 47 it can be seen that the productivity of both mutations is acceptable compared to that of standard Elstar. Also fruit size, measured as average fruit weight, is almost the same for the 3 Elstar-types. Size grading at the experimental orchard at Horst in 1991 indicated that standard Elstar had the highest percentage of fruits in Class > 70 mm (91.6 %); for Elshof and Red Elstar these figures were respectively 85.1 and 87.6 %. Grading in 1992 in the same orchard indicated that Red Elstar, standard Elstar and Elshof had respectively 98.2, 94.9, and 91.2 % fruits > 70 mm. It seems, therefore, that Elshof has somewhat smaller fruits than Red Elstar and Elstar standard. Both colour mutations have a higher percentage of red-blushed fruit skin. As is shown in Table 47 Red Elstar had 8 % more and Elshof 14 % more fruits with over 50 % of the fruit skin red-blushed compared to standard Elstar. In 1991 these figures were respectively 9 and 14 %.

Jonagold

In Tables 48 and 49 results are given of the trial, planted in 4 regional experimental orchards in the spring of 1987, in which 6 mutations of Jonagold are compared.

Table 48. Results of testing Jonagold clones (87.0.9).

Clone*		Kg/tree 1988- 1992 **	% of the yield 1992 in			% fruits in 1992 with			
			pick 1**	pick 2**	pick 3**	0-10 % blush ***	11-50 % blush ***	51-75 % blush ***	76-100 % blush ***
T 1272	vv	110.8	33	45	23	9.5	61.2	24.9	4.5
2291 T	vv	114.0	31	47	22	8.0	65.3	22.8	4.0
Wilmuta	vv	115.7	37	43	20	8.4	57.5	29.1	5.2
New Jonagold	vz	96.4	44	41	15	3.9	47.5	38.2	10.6
Jonagored	vz	99.2	86	13	1	0.1	4.4	17.6	78.1
Jonaveld	vz	101.9	83	14	3	0.1	5.3	32.0	62.6

* vv = virus-free; vz = not virus-free.

** Average figures of 4 experimental orchards.

*** Average figures of 2 experimental orchards.

As is shown in Table 48 the non virus-free clones produced 11-15 % less kg per tree after 6 growing seasons than the virus-free standard clone 2291 T. The 2 dark red clones Jonagored and Jonaveld only need 2 pickings, while the others need at least 3 picking times. In this trial there are 3 groups of Jonagold with respect to fruit skin colour. The clones T 1272 and 2291 T are least blushed; Wilmuta has only a slightly higher percentage of fruits with more than 50 % red blush; with New Jonagold this percentage is somewhat higher. Jonagored and Jonaveld are most blushed. Both mutations have a similar percentage of fruits with over 50 % red blush.

Table 49. Results of testing Jonagold clones (87.0.9).

Clone*		Average weight (g) 1988-1992**	% fruits***		
			< 80 mm	80-90 mm	> 90 mm
T 1272	vv	245	20.1	48.6	31.2
2291 T	vv	247	19.3	46.1	34.5
Wilmuta	vv	243	21.1	51.3	27.7
New Jonagold	vz	235	27.2	50.3	22.4
Jonagored	vz	233	33.3	51.4	15.3
Jonaveld	vz	228	30.2	50.3	19.7

* vv = virus-free; vz = not virus-free.

** Average figures of 4 experimental orchards.

*** Figures are averages of grading in 1990 (Zeewolde), 1991 and 1992 (Horst).

As shown in Table 49 the non virus-free clones have a lower average fruit weight than the virus-free clone. Also fruit size grading indicated that the non virus-free clones have a somewhat higher percentage of fruits smaller than

80 mm and a lower percentage of fruits bigger than 90 mm.

In the spring of 1992 a trial was planted in 3 experimental orchards in which 13 colour mutations of Jonagold are compared. In this trial Wilmuta is serving as standard Jonagold. The trees were raised in one nursery, using the newest virus-free propagating material if available. First results are given in Table 50.

Table 50. Results of testing Jonagold clones (92.0.1).

Clone*		At planting date**		Kg/tree 1992 ***	Average fruit weight (g) 1992 ***
		Trunk cir- cumference (cm)	Number of laterals		
Wilmuta	vv	4.8	7.4	0.9	257
Crowngold	vv	4.8	8.2	0.9	256
Schneica B	vv	4.7	7.0	0.8	265
King Jonagold 8765T	vv	4.8	7.2	1.0	274
Jonakap	vv	4.9	7.6	0.9	246
Decosta	vv	4.7	7.5	1.2	268
Jonagored 9614	vv	4.6	6.9	0.9	270
Jonagored HR 2458	vv	4.7	6.8	1.1	269
Jonabel	vz	4.7	6.9	0.8	294
Jonagold 2000	vz	4.7	6.2	0.8	273
Novajo	vz	4.7	7.3	0.7	258
Jonaveld	vz	4.7	7.3	0.8	258
Jomured	vz	4.8	8.2	0.7	310

* vv = virus-free; vz = not virus-free.

** Average figures of 3 experimental orchards.

*** Average figures of 2 experimental orchards.

In Table 50 it can be seen that the average trunk circumference at the planting date varied between 2 % more (Jonakap) and 4 % less (Jonagored) than standard Wilmuta. The number of laterals at the planting date varied between 11 % more (Crowngold, Jomured) and 16 % less (Jonagold 2000) than Wilmuta. No reliable conclusions can be drawn from the first yields in the year of planting.

CULTIVAR TESTING WITH PEAR

H. Kemp and P.D. Goddrie

Cultivar trials in Wilhelminadorp

Fourteen new cultivars were planted in the pear cultivar trials in Wilhelminadorp in the spring of 1992. Amongst those cultivars were 6 red skinned pears and 3 colour mutations of Beurré Hardy. In winter 1992/1993 8 cultivars were withdrawn from the collection (table 51).

Concorde (Doyenné du Comice x Conference) yielded 23 kg/tree in 1992. The accumulated yield is 65 kg/m³ tree volume. The yielding capacity (kg/m³) from 1987 up to and including 1992 is 10 % higher than that of Conference. The

Table 51. Data of 8 pear cultivars discontinued at the end of 1992.

Cultivar	Origin	Planted	Disapproved for
CPRO 68007-123	The Netherlands	1987	unattractive fruit appearance
CPRO 68013-38	The Netherlands	1987	unattractive fruit shape
CPRO 69013-18	The Netherlands	1987	susceptible to biennial bearing
CPRO 69025-56	The Netherlands	1987	unsatisfactory eating quality, somewhat insipid
CPRO 70025-1	The Netherlands	1987	insufficient yield, unattractive fruit appearance
I/5	Yugoslavia	1987	very susceptible to blossom blast, insufficient yield
IV/45	Yugoslavia	1987	poor-moderate eating quality, insipid
VI/6	Yugoslavia	1987	short shelf life, unsatisfactory eating quality

average fruit weight of Concorde from the 6 production years (1987 - 1992) was only a few grams higher than that of Conference. Regarding the storability of Concorde: see page 93. (Optimum storage conditions and ability to use storage techniques on pome fruit).

In a taste experiment, carried out at Wilhelminadorp at the beginning of December 1992, the taste of Concorde was rated significantly lower than that of Doyenné du Comice (Table 52). Concorde tastes sweeter (less acid) than Doyenné du Comice and the fruit flesh is noticeably more crunchy.

In 1992 the taste of the Dutch selection CPRO 66006-273 was obviously lower than in 1990 and 1991. The low score of 1992 (Table 52) probably was a result of the fruits being too acid. The fruits of all cultivars used in this taste experiment were stored at 21 % O₂ and -0.5 °C until 7 days before testing.

Table 52. Results taste experiment with pear cultivars at Wilhelminadorp (PFW), December 1992 (1 = very poor, 9 = excellent).

Cultivar	Score
Doyenné du Comice	7.7 a
Concorde	6.2 b
Dolacomí (Jowil TM)	5.7 b
Bonne Louise d'Avranches	4.7 c
CPRO 66006-273	4.7 c

Values followed by the same letter do not differ significantly (P = 0.05).

The English pear selection JI 7451 (Laxton's Superb x Doyenné du Comice) has been called Dolacomí (JowilTM) since 1992. Jowil is the trade mark. In 1992 the yield of Dolacomí was very good again. Although some biennial bearing appeared, the worst bearing tree still yielded 16 kg/tree. During the period 1984 - 1992 Dolacomí yielded 25 % more per m³ tree volume than Conference. The fruits of Dolacomí were large during the 9 years, but not larger than those of Doyenné du Comice. The idea, formed in 1990, that small fruits should have appreciably less taste than large ones (> 70 mm), was tested again in 1992 (Table 53). Again this year the taste of the small fruits (< 65 mm) from heavily bearing trees (40 kg/tree) was rated significantly lower than the taste of fruits (big or small) from moderately bearing trees (17 kg/tree). The

difference is caused by a lower sugar content in the fruits (especially the small ones) from the (too) heavily bearing trees, that probably is related to a (too) low leaf/fruit-ratio. The remarks of the tasters show, that the taste of the (small) fruits with a low sugar content was somewhat watery and/or acid. Therefore, some fruit thinning on the heavily bearing trees seems to be necessary. A complete cultivar description of Dolacomí is given in the Dutch fruit magazine *Fruittelt* 83(1993)10:16-17.

Table 53. Results of a taste experiment with different fruit sizes of Dolacomí (JowilTM) at Wilhelminadorp (PFW), November 1992 (1 = very poor, 9 = excellent).

Treatment	Fruit size	Score
Moderately bearing, large fruits	> 80 mm	6.2 a
Moderately bearing, small fruits	65-70 mm	5.8 a
Heavily bearing, large fruits	70-80 mm	6.4 a
Heavily bearing, small fruits	60-65 mm	5.1 b

Values followed by the same letter do not differ significantly ($P = 0.05$).

Again in 1992, the fruits of the russeted Conference mutation Conference Brons were on average 40 % more russeted than standard Conference. In the spring of 1990 a Conference mutation was planted, that should ripen earlier than standard Conference. This strain, Conference Saels II, indeed ripened more than 2 weeks earlier than standard Conference in 1992.

The Canadian fire-blight resistant cultivar Harrow Sweet (HW609) yielded 29 kg/tree in 1992. However, during the years 1988 up to and including 1992 the yield was still 12 kg/tree lower than that of Conference. The fruit taste is (rather) good and sweet. The results of 1992 correspond with the French results: good yields but small fruits. The average fruit weight was only 137 grams at Wilhelminadorp in 1992, although the yield per tree was normal considering the tree size. The small fruits mean that this cultivar is of no interest to the Dutch fruit growing industry.

Virus infected trees of the nearly totally red skinned pear cultivar Lombacad (Cascade (R): Max Red Bartlett x Doyenné du Comice) were planted in the spring of 1990. In 1992 this cultivar gave a small yield. The fruit shape resembled that of Doyenné du Comice, but the fruit taste was noticeably inferior.

Three cultivars of the 25 cultivars planted in the spring of 1990 attracted attention by showing a good fruit taste in 1992. One of those was the rather early ripening French cultivar Deleté. The other 2 cultivars were the French cultivar Delbuena (Peradel (R) - RX 1502) and the French selection 6.30.100. Unfortunately, the attractiveness of the fruits of 6.30.100 was substantially reduced by russetting and cracks. The fruit appearance of Delbuena is not so attractive either, but is probably still sufficient.

The cultivars Abate Fétel and Baurotard (Dairain (R)) show a high level of incompatibility with Quince MC.

In the spring of 1990 10 trees were planted of the old French cultivar Pierre Corneille (Beurré Diel x Doyenné du Comice). The trees on Quince MC with interstem Beurré Hardy grew (very) vigorously. The yield per tree up to and including 1992 was 18.5 kg, which is substantially higher than Conference. The taste of Pierre Corneille is rather good, with occasionally a scent of musk, but is still inferior to that of good Conference (Table 54). In November 1992 and March 1993 taste experiments were carried out at Wilhelminadorp with President Loutreuil, Conference and Pierre Corneille from the Research Station

(PFW) and/or from a fruit farm. The figures in Table 54, together with the remarks of the tasters, show that President Loutreuil and Pierre Corneille are different cultivars. President Loutreuil rated significantly lower and is also more acid/less sweet than Pierre Corneille. The fruit appearance of President Loutreuil and Pierre Corneille is very similar, although there is a slight difference between the fruit stalks. The comparison of Pierre Corneille with President Loutreuil was done because, in old literature, Pierre Corneille is mentioned as a synonym of President Loutreuil.

Table 54. Results of a taste experiment with pear cultivars at Wilhelminadorp (PFW), (1 = very poor, 9 = excellent).

Cultivar	Score	
	November 1992	March 1993
Conference fruit farm	---	6.8 a
Pierre Corneille fruit farm	6.8 a	6.5 ab
Conference PFW	---	6.1 b
Pierre Corneille PFW	6.7 a	5.9 b
President Loutreuil	5.9 b	---

Values in 1 column followed by the same letter(s) do not differ significantly (P = 0.05).

Cultivar trials in regional experimental orchards

The results (Table 55) of the national pear cultivar trial (second

Table 55. Results of 10 CPRO selections and 2 standard cultivars in a pear cultivar trial, planted in 5 experimental orchards in 1988 (88.1.2).

Cultivar	Kg/tree* 1989-1992	Average* fruit weight (g) 1989-1992	Tree volume (m ³) **	Firmness (kg/0.5 cm ²) ***	Sugar content ****
CPRO 6403-23	30	233	1.4	5.44	10.4
CPRO 66006-273	21	194	0.7	5.55	11.0
CPRO 68006-123	53	227	1.0	7.54	10.5
CPRO 68007-123	31	-	1.2	5.59	13.2
CPRO 68013-38	39	-	0.9	-	-
CPRO 69007-36	29	239	1.0	5.78	10.2
CPRO 69013-18	18	-	1.3	4.57	15.9
CPRO 69025-56	26	-	1.1	3.42	10.6
CPRO 70009-29	32	258	0.7	7.19	9.7
CPRO 70025-1	11	-	0.7	5.88	10.6
Conference	37	218	1.1	6.53	12.5
Doyenné du C.	22	256	0.9	5.26	11.7

* Average figures of the 4 Dutch experimental orchards.

** Average figures of the experimental orchards in Geldermalsen, Numansdorp and Zeewolde, spring 1992.

*** Measured 1 week after harvest, Velm (Belgium) 1992.

**** Measured with a hand refractometer (% brix), 1 week after harvest, Velm (Belgium) 1992.

screening cultivar trial), planted in the 4 Dutch regional experimental orchards and the Nationale Proeftuin voor Grootfruit in Velm (Belgium) in the spring of 1988, show that the selections CPRO 68006-123 (Packham's Triumph x Souvenir de Jules Guindon) and CPRO 68013-38 (Conference x Packham's Triumph) yielded more per tree and per m³ tree volume than Conference. Unfortunately, the fruit appearance of both selections is unattractive. The yield of the selection 70025-1 (Packham's Triumph x Doyenné du Comice) remains low up to the present time. CPRO 69013-18 (Doyenné du Comice x Précoce de Trévoux) yielded only moderately, also because of its tendency to biennial bearing.

CPRO 66006-273 (Bonne Louise d'Avranches x Doyenné du Comice) yielded less per tree, but as much as Conference per tree volume. The fruits of this selection resemble a large Bonne Louise d'Avranches fruit. In 1990 CPRO 66006-273 was noticeable because of its good taste, but in 1991 and 1992 the taste was too acid (like Bonne Louise d'Avranches).

The screening of the selections CPRO 68006-123, CPRO 68007-123, CPRO 69013-18, CPRO 69025-56 and CPRO 70025-1 in the 4 regional orchards was ended in the spring of 1992. Only CPRO 66006-273 and CPRO 69007-36 (Clapp's Favourite x Doyenné du Comice) seem to be promising at the moment, although the yield and taste of CPRO 69007-36 were not better than that of Conference.

Clone testing in Wilhelminadorp

A trial with virus free (sub) clones of Doyenné du Comice was planted in the spring of 1986 (2-year-old trees on Quince MC). The Belgian T 1388, clone 10-21 and M.204 (from England) appear more and more to be the best.

Table 56. Results of a trial with Doyenné du Comice clones, planted in Wilhelminadorp in 1986 (86.1.2).

Clone	Tree volume (m ³) spring 1992	Yield (kg/m ³) 1988-1992	Yield (fr./m ³) 1988-1992	Average* size index 1990-1992	Average fruit weight (g) 1988-1992
T 1388	0.72 a	51.1 a	167 a	636 b	308 a
9-3	0.63 a	19.9 b	73 b	662 a	280 ab
10-21	0.83 a	46.3 a	152 a	658 a	304 a
10-28	0.80 a	39.5 a	130 a	664 a	300 a
M.204	0.75 a	43.6 a	166 a	620 b	260 b
9-6	0.67 a	33.9 a	113 ab	667 a	300 a

Values in 1 column followed by the same letter(s) do not differ significantly (P = 0.05).

* The size index is the sum of the weight percentages in a certain size class, multiplied with a constant (< 65, 65-75, 75-85, 85-95, > 95 mm; multiplied with 2, 4, 6, 8, 9).

(The T of T 1388 means: Top graft number. A T number is given to an isolated and grafted shoot tip after this tip has been made virus free.) With the same number of fruits per m³ tree volume T 1388 produced significantly heavier fruits than M.204 (Table 56). Clone 9-3 and 9-6 fall behind somewhat in respect of tree growth. Those clones also showed less growth in the fruit tree nursery. The significantly smaller yield of clone 9-3 (Table 56) corresponds with the significantly lower amount of flowering during the years 1990 - 1992. Clone 10-21 and T 1388 flowered the most profusely during these years, although not significantly more than the others. In 1992 it was obvious, that the higher the yield per tree the lower the amount of bronze/russetting on the

fruits. The tree quality and yield of all clones was probably harmed by frost damage during the nursery period.

CULTIVAR TESTING WITH STONE FRUIT

H. Kemp and P.D. Goddrie

Plum cultivar trials in Wilhelminadorp

In 1992 20 new plum cultivars were planted in the plum cultivar trials in Wilhelminadorp. Amongst those cultivars were 10 cultivars from Canada, 3 from Romania and 3 from Sweden.

The Swedish cultivars Jubileum and Ive, planted in the spring of 1988 and replanted in 1989, yielded up to and including 1992 respectively 5.8 and 1.0 kg/tree. The fruits of Jubileum weighed more than 70 grams and had a rather good taste. Ive had somewhat less taste and the fruit size was somewhat smaller (62 grams). Reine-Claude Souffriau, planted in the spring of 1987 and replanted in 1989, yielded including 1992 1.7 kg/tree. The attractive, dark blue fruits of Reine-Claude Souffriau had a good taste. All plum cultivars were grafted on St. Julien A.

Plum cultivar trials in regional experimental orchards

A trial was planted with 8 plum cultivars in the regional experimental orchards in Geldermalsen and Zeewolde in the spring of 1987 (1-year-old trees on Pixy). Of the new cultivars, only Ive has yielded well up until now, but the yield of this cultivar also fell behind that of the standard cultivars Anna Späth, Bleue de Belgique and Victoria. Ive is also the most vigorous cultivar in this trial.

Sweet cherry cultivar trials in Rillaar (Belgium)

J. Verheyen, K. Belmans and H. Kemp

In 1992 there was again a close co-operation concerning sweet cherry

Table 57. Productivity, firmness, fruit weight and picking date of some interesting sweet cherry cultivars in Rillaar (Belgium).

Cultivar	Productivity (1 - 10)	Firmness (20 - 60)	Fruit weight (g)	Picking date 1992
Vista	8	35	8.1	18 June
Sylvia	3	44	9.2	25 June
NY 6476	10	49	6.9	29 June
NY 3308	10	40	6.4	29 June
Kristin	7	39	-	30 June
Sunburst	6	38	9.4	08 July
13S-27-17	7	40	9.7	14 July
Lapins	7	45	9.2	14 July
13S-49-24	9	42	9.0	14 July

cultivar testing with the Fruitteeltcentrum of the Catholic University Leuven in Aarschot-Rillaar (Belgium). Seventy six cultivars were under trial in 1992, planted in the spring of 1988 up to and including 1992. All cultivars were grafted on the moderately vigorous rootstock GM 61/1 (Damil). 1992 produced a good harvest. The productivity was observed on the tree and scored with a bearing figure (1 = very poor yield, 10 = excellent yield). The average fruit weight was determined from a sample. In Table 57, using some interesting cultivars, these figures are listed, together with the picking date and a figure representing fruit firmness (20 = soft, 60 = very firm).

POLLINATION OF POME AND STONE FRUIT

H. Kemp

Crossings

Manual crossings are carried out annually with apple, pear and plum cultivars to investigate whether they can be combined in orchards with regard to cross pollination. In 1992 crossings were made with apple and pear cultivars, the results of which are mentioned in Table 58. The crossings were done at Wilhelminadorp, Numansdorp and Zeewolde. For each crossing 100 flowers were used: 5 branches with 10 clusters with 2 flowers per cluster. The stigmas were covered with Vaseline directly after pollination.

Generally speaking the fruit set was good in 1992. Elise is suitable as a pollinator for Cox's Orange Pippin and Discovery. Elise appeared to be not so suitable as a pollinator for Boskoop, because of the rather low fruit and seed set percentages and the (too) small overlap of the flowering periods.

Discovery (less susceptible to scab) is suitable as a pollinator for the scab resistant CPRO selection 78039-18. Discovery, Elstar, Golden Delicious, James Grieve and Zoete Oranje are all suitable as pollinators for Delcorf. Delcorf,

James Grieve and Rafzubin (Rubinette (R)) are suitable as pollinators for Elise.

Concorde seemed to be fairly self fertile. Self pollination will be repeated to be sure of the level of self fertility. In 1991 CPRO 66006-273 and Dolacomì gave only a low fruit set with Concorde. This year, with no spring frosts during the flowering period, both cultivars gave a good fruit set. The overlap of the flowering periods of those 3 cultivars was also good, so they are suitable as pollinators for each other. Gieser Wildeman seems to be a suitable pollinator for Concorde. Concorde, Conference and Gieser Wildeman gave sufficient fruit set with CPRO 66006-273. The combination of CPRO 66006-273 (Bonne Louise d'Avranches x Doyenné du Comice) and Doyenné du Comice gave only small amounts of fruit set reciprocally, which is probably (partially) due to relationship. Concorde, Conference and CPRO 66006-273 gave sufficient fruit set with Dolacomì. They are suitable pollinators for each other, because the overlap of the flowering periods is also sufficient. Gieser Wildeman gave a somewhat low fruit set. Dolacomì seems to be not self fertile. Both combinations will be repeated. Dolacomì is suitable as pollinator for Conference and Doyenné du Comice.

Table 58. Fruit set percentages at picking time and numbers of good seeds per fruit of apple and pear crossings made in 1992.

Pollinated cultivar	Pollinator	% fruit set	Good seeds/fruit
<u>Apple</u>			
Cox's Orange Pippin	Elise	32	3.4
Cox's Orange Pippin	Elise	22	3.8
Cox's Orange Pippin	Golden Delicious	24	2.1
CPRO 78039-18	Discovery	26	4.1
CPRO 78039-18	Discovery	27	3.8
CPRO 78039-18	Golden Delicious	14	4.5
Delcorf	Discovery	39	4.4
Delcorf	Elstar	25	5.3
Delcorf	Golden Delicious	32	4.2
Delcorf	James Grieve	24	4.1
Delcorf	Zoete Oranje	20	5.0
Discovery	Elise	27	7.7
Elise	Delcorf	40	4.0
Elise	James Grieve	26	3.1
Elise	Rafzubin	51	4.8
Rode Boskoop	Elise	17	1.1
<u>Pear</u>			
Concorde	Concorde	10	1.7
Concorde	Conference	31	2.4
Concorde	CPRO 66006-273	33	2.3
Concorde	Dolacom (Jowil TM)	34	3.5
Concorde	Gieser Wildeman TM	41	2.0
Conference	Dolacom (Jowil TM)	55	2.6
CPRO 66006-273	Concorde	32	5.8
CPRO 66006-273	Conference	15	3.8
CPRO 66006-273	Doyenné du Comice	8	2.6
CPRO 66006-273	Gieser Wildeman	21	3.7
Dolacom (Jowil TM)	Concorde	16	3.5
Dolacom (Jowil TM)	Conference	17	3.2
Dolacom (Jowil TM)	CPRO 66006-273	18	3.0
Dolacom (Jowil TM)	Dolacom (Jowil TM)	1	1.0
Dolacom (Jowil TM)	Gieser Wildeman	9	2.9
Doyenné du Comice	Conference	22	1.7
Doyenné du Comice	CPRO 66006-273	11	2.5
Doyenné du Comice	CPRO 66006-273	7	2.6
Doyenné du Comice	Dolacom (Jowil TM)	23	2.6

SMALL FRUIT

STRAWBERRY CULTIVAR TRIALS

J. Dijkstra and A.A. van Oosten

Glasshouse strawberries

At the experimental centre in Breda several CPRO selections and Lambada were compared with Elsanta in a culture with an autumn plus a spring crop. In a culture with only a spring crop some CPRO selections and Lambada were compared with Primella and Elsanta.

During both the autumn and spring parts of the long culture, production of the new selections and Lambada stayed far behind Elsanta. Moreover, fruits lacked the firmness of Elsanta.

Also, in the early forced culture Elsanta was the cultivar with the highest productivity. As in previous years, production of the CPRO selections stayed far behind. Productivity of Lambada was reasonable, but fruits were too vulnerable and tender. The ripening period of Lambada fell between those of Primella (earliest) and Elsanta.

June bearing cultivars in the open

National cultivar trial

At the experimental centres in Breda, Geldermalsen (Ge) and Horst and at the Research Station (PFW) a number of Dutch selections and some cultivars from abroad were compared with Elsanta, Avanta and Lambada. The results are summarized in Tables 59 and 60.

There were quite big differences between the 4 trials. Production in Geldermalsen was very low. There, it seems impossible to get sufficient growth directly after planting on the heavy clay soil. This trial will be continued for a second cropping year. At all experimental stations the percentage of second quality fruit was high; this was in contrast to the Research Station. However, in Wilhelminadorp the percentage of fruit rot was unexpectedly high, due to heavy rain fall in the first half of June. This caused damage especially to the mid-season cultivars.

Again, Elsanta proved to be a reliable cultivar with a good yield in all trials. Its percentage of second quality fruit was average, as was its average fruit size. Productivity of Avanta was only moderate and fruits were rather vulnerable and tender. Especially in Breda many Avanta plants were lost due to *Phytophthora cactorum*. Productivity of Lambada was also only moderate. However, fruit quality of this cultivar was excellent. The fruits were easy to pick, had a nice colour, were firm and had an excellent taste.

Also, the 3 CPRO selections were only moderately productive. CPRO 1013 and CPRO 1015 ripen early. CPRO 1013 has small fruits that crack, and a high percentage of second quality fruits. Fruits of CPRO 1015 are very soft. Plants of the mid-season ripening CPRO 1009 stayed short with short fruit trusses. Taste was good. Because none of the selections was an improvement of the assortment, they were all rejected.

Of the foreign cultivars the early-ripening Honeoye had nice plants with a reasonable yield. Also, taste was reasonable and Honeoye will be judged again in 1993. Raftzusen ripened at mid-season with a reasonable production of large fruits. The first fruits had an irregular shape and an ugly purple-red colour.

Taste was bad. Later in the season fruit quality improved. Raftzusen will not be included in further trials because it certainly is not an improvement on Elsanta. Again, Pegasus gave a good production. This cultivar has healthy growth and ripens some days after Elsanta. However, because of its insufficient taste Pegasus will not be included in further trials.

Table 59. Productivity (1st and 2nd quality) in kg/m² and percentage 2nd quality.

Cultivar	Kg 1 st and 2 nd quality/m ²				% 2 nd quality*			
	Breda	Ge	Horst	PFW	Breda	Ge	Horst	PFW
Elsanta	3.32	1.10	3.65	2.10	24	21	25	13
Avanta	1.15	0.54	1.69	1.66	29	31	14	4
Lambada	1.17	0.36	1.35	1.80	14	16	18	4
CPRO 1009	1.41	0.33	1.60	1.69	22	39	25	16
CPRO 1013	0.97	0.36	2.77	1.76	40	37	36	17
CPRO 1015	1.33	0.72	1.28	1.93	30	29	21	6
Honeoye	1.85	0.60	2.40	2.01	29	30	11	5
Marmolada	-	0.51	-	1.02	-	10	-	4
Pegasus	2.77	1.13	2.27	2.13	18	33	16	8
Raftzusen	2.15	0.71	2.30	2.17	6	16	25	10
Sel. de Weert	1.48	0.39	4.83	2.25	14	50	30	28

* Of first and second quality.

Only cold stored runner plants of Marmolada were available. These plants were planted at the same date as the fresh plants. Probably, through that production was moderate. Fruits were very large and firm, but somewhat dry with only little taste and aroma. In Wilhelminadorp, Marmolada was very susceptible to fruit rot. This cultivar will be judged again in 1993.

Table 60. Percentage fruit rot and average fruit weight of first quality fruits.

Cultivar	% fruit rot*				Average fruit weight (g)				M.h.d.**
	Breda	Ge	Horst	PFW	Breda	Ge	Horst	PFW	
Elsanta	2	1	3	32	14.7	19.2	16.9	15.0	10 June
Avanta	3	0	3	17	16.4	15.7	18.0	14.8	2 June
Lambada	1	2	2	9	15.2	17.4	20.4	17.1	4 June
CPRO 1009	3	2	3	17	16.4	17.9	18.2	16.6	14 June
CPRO 1013	4	0	2	13	14.7	13.9	14.7	11.7	3 June
CPRO 1015	3	0	2	11	15.6	15.7	16.8	14.1	2 June
Honeoye	3	0	1	6	15.2	15.5	17.7	14.8	3 June
Marmolada	-	3	-	48	-	24.5	-	23.1	8 June
Pegasus	1	2	3	23	13.2	18.0	18.5	14.6	13 June
Raftzusen	3	3	3	30	23.3	21.5	22.3	18.7	13 June
Sel. de Weert	2	3	4	5	17.5	17.1	15.5	12.7	23 June

* Of first and second quality and rot.

** Mean harvest date.

Selection De Weert was extremely late ripening but gave an insufficient

result on clay soils (little growth, insufficient fruit quality and much *Verticillium* wilt). However, on the sandy soils results were much better and it was decided to include Selection De Weert again in the trials for 1993.

Fruits of the trial in Wilhelminadorp were measured several times for firmness with the Instron. Marmolada and Elsanta were firmest, followed by Lambada, Pegasus, Honeoye and CPRO 1009. Avanta proved to be very soft, but CPRO 1015 and Raftzusen also had low values for firmness. Due to its late ripening time Selection De Weert could only be judged once together with other cultivars. Then, its firmness was good.

In general it can be said that as harvest progressed, the fruits became smaller and firmer.

Cold-stored waitingbed plants

In Breda cold stored plants of Lambada, Pegasus, Honeoye and CPRO 1013 were compared with Elsanta. Planting date was 14 May 1992. Elsanta gave the best results with a good production and large fruits. Production of Lambada, CPRO 1013 and Honeoye was insufficient. Plants of Pegasus grew well and gave a reasonable production, but again taste was insufficient.

Everbearing cultivars

National cultivar trial

At the experimental station in Zwaagdijk and at the Research Station (PFW) 5 everbearing CPRO selections and the cultivars Muir, Irvine and Calypso were compared with the standard cultivars Rapella and Selva. In Wilhelminadorp the cultivars Mrak, Darestival and Darflash were added. As in 1991 in Zwaagdijk the plants were planted in the open; in Wilhelminadorp they were planted in

Table 61. Results of the cultivar trials with everbearers.

	Kg/m ² 1 st +2 nd quality		% 1 st quality*		Average fruit weight (g)**		Mean harvest date	
	Zwaagd.	PFW	Zwaagd.	PFW	Zwaagd.	PFW	Zwaagd.	PFW
Rapella	3.31	3.86	99	91	18.4	13.7	30 Aug.	7 Aug.
Selva	2.40	3.36	100	97	27.3	18.0	2 Sep.	15 Aug.
CPRO 1026	3.38	4.48	99	93	21.6	13.9	31 Aug.	28 July
CPRO 1027	2.11	3.52	99	94	18.6	15.6	1 Sep.	12 Aug.
CPRO 1028	2.31	2.34	98	81	13.4	11.6	25 Aug.	28 July
CPRO 1030	2.20	3.12	99	92	15.8	14.2	2 Sep.	28 July
CPRO 1036	2.04	3.50	100	94	14.7	13.6	29 Aug.	5 Aug.
Muir	1.89	2.31	98	94	19.3	15.7	30 Aug.	9 Aug.
Irvine	1.49	2.62	97	91	13.6	13.8	20 Aug.	3 Aug.
Calypso	2.80	3.61	97	92	15.3	14.7	26 Aug.	5 Aug.
Mrak	-	3.74	-	87	-	12.5	-	31 July
Darestival	-	3.48	-	96	-	16.6	-	9 Aug.
Darflash	-	3.26	-	96	-	13.9	-	12 Aug.

* Of first and second quality.

** First quality only.

peat bags and cultivated under a plastic roof. Plant density was 2.2 plants/m²

in Zwaagdijk and 3 plants/m² in Wilhelminadorp. The results are summarized in Table 61.

Only CPRO 1026 was as productive as Rapella. Also, Calypso gave a reasonable production. The other cultivars and selections appeared to be much less productive than Rapella. Especially in Zwaagdijk differences in production were large. Although in Wilhelminadorp (under plastic) harvest continued for a long period, the mean harvest date was quite early.

Selva and Muir produced the biggest fruits; in Zwaagdijk also fruits of CPRO 1026 and in Wilhelminadorp fruits of CPRO 1027 were bigger than those of Rapella.

The qualities of the selections and cultivars can be summarized as follows:
CPRO 1026: growth open and a strong, productivity good with fruits on long trusses. Fruit quality was sufficient with a moderate taste. Will be judged again in 1993.

CPRO 1027: moderate growth with bushy plants. Productivity was insufficient in Zwaagdijk. Fruit quality differs from year to year. Is rejected.

CPRO 1028: rather short and somewhat bushy plants. Productivity insufficient in Wilhelminadorp and good in Zwaagdijk, but fruits were small. Is rejected.

CPRO 1030: rather short and somewhat bushy plants. Productivity and fruit size were reasonable. Fruits were vulnerable and had a short shelf life. Is rejected in spite of its good taste.

CPRO 1036: nice, open plants. Productivity was insufficient in Zwaagdijk, but good in Wilhelminadorp. Fruits had a reasonable size with a very good quality. Seemed susceptible to mildew but will be judged again in 1993.

Irvine: growth was irregular and insufficient with a low yield and rather small fruits. Taste was moderate to bad. Is rejected.

Muir: rather small but firm plants. Production was disappointing, but probably can be improved. Fruits were firm and taste good. Will be judged again in 1993.

Calypso: gave quite strong plants with a production that was reasonable to good. Especially in Wilhelminadorp, at first fruit form was very irregular. Fruits were firm and had a reasonable shelf life, but taste was only moderate. Will be judged again in 1993 because of its good productivity.

Finally, in Wilhelminadorp Mrak, Darestival and Darflash were included in the trial. Mrak gave short plants with a good production. However, fruits were too small and had only a moderate quality. Darestival had very strong growing plants with very long fruit stalks. Productivity was good, but fruit quality was insufficient. Darflash also gave very good growth with a reasonable production. Fruits were firm, not very vulnerable and had a reasonable, somewhat sour taste. Seems only slightly susceptible to mildew. Only Darflash will be included in the 1993 trials.

Evaluation of in vitro plants

The Bedrijfslaboratorium voor Weefselweek (Laboratory for Tissue Culture) in Roelofarendsveen keeps a stock of a number of strawberry cultivars in vitro so that there is healthy material available in case something happens with the normal virus-free stock. Because there have been some problems with in vitro strawberry plants in the past it is desirable to judge the productivity and fruit quality of the in-vitro stock now and then. In 1991 young plants were obtained from in vitro propagated mother plants of Karina, Elsanta, Tenira and Bogota. Runnering was poor, so that the production field was planted late and yields in 1992 were low. There were no reliable differences in yield between the different sources of a cultivar. Both origins of Bogota showed June

yellows. However, it was striking that the progeny of in vitro plants showed less severe symptoms than the standard plants.

DEVELOPMENT OF METHODS FOR AN EARLY AND LATE HARVEST OF CURRANTS, RASPBERRIES, BLACKBERRIES AND BLUEBERRIES

J. Dijkstra, A. Scholtens and W.A.G.M. Jansen

Raspberry

Comparison of plant material Wilhelminadorp

In co-operation with a foreign nursery in an early culture with Glen Moy and Glen Prosen plants from the middle and from the sides of a 1.5 m wide nursery bed were compared. The aim was to check if better light conditions on the sides of a bed resulted in better development of the buds into laterals, and therefore led to a higher production. Moreover, plant densities of 4 and 12 plants per m row in a V-hedgerow system were compared. In all treatments 7.5-l pots were used with 2 plants. Unfortunately development of all plants was very irregular and quite a large number of buds did not develop at all. Because of that, judgment of the plants was difficult.

With Glen Prosen there were no reliable differences between the treatments. With Glen Moy there was a tendency for plants from the middle of the bed to yield somewhat better. It was striking that with 12 (2 x 6) plants per meter row, production per plant was 15 - 25 % lower than with 4 (2 x 2) plants per meter row. It seems that with 6 x 2 plants per meter row there is already such a competition for light that production per plant decreases. For both cultivars there was no clear influence of the treatments on fruit size.

Use of potted raspberry plants in an early crop for more than one year (Geldermalsen).

As a continuation of trials in 1990 and 1991 a multi-year culture of potted Glen Clova plants was compared with a culture of new plants. Originally the plants were partly obtained from a normal propagation field and partly from

Table 62. Results of a comparison of plant types, pot sizes and duration of culture.

Treatment	Kg/m ²		% 2 nd	Average fruit weight (g)
	1 st	qual. Total quality		
3 years old, normal pl., 1 cane /10-1 pot	1.20	1.83	34	3.3
3 years old, normal pl., 2 canes/10-1 pot	1.54	2.51	39	3.6
3 years old, normal pl., 2 canes/15-1 pot	1.58	2.26	30	3.5
3 years old, special p., 1 cane /10-1 pot	1.21	1.97	39	3.5
3 years old, special p., 2 canes/10-1 pot	1.43	2.24	36	3.3
3 years old special p., 2 canes/15-1 pot	1.50	2.34	35	3.5
1 year old, special p., 1 cane /10-1 pot	1.29	1.77	28	3.0

special fields with better light conditions for the plants. Furthermore, 1 plant per 10-1 pot was compared with 2 plants per 10-1 pot and per 15-1 pot.

Because in 1990 and 1991 it was clear that specially grown plants gave a much better production, in 1992 only specially grown plants were used as new plants. The results are summarized in Table 62.

Compared to 1991 the average production level was only moderate. This was probably caused by the weather conditions: a sudden break from cool, dreary weather to hot and dry weather reduced growth and shortened the harvest period. The after-effect of the special treatment in the second harvest year now no longer existed: there were no differences between the "plant types". In contrast to previous years, when a bigger substrate volume resulted in a higher production, now 1 plant per 10-l pot gave a somewhat lower yield. New plants were as productive as the older ones and differences in fruit quality were small. Only the new plants gave somewhat smaller fruits.

The conclusion for the 3 years together is that it is quite possible to grow raspberries for 3 years in the same pots. In the first as well as in the second year specially grown plants produced more than normal propagation field plants. In general, already established plants are more productive than new plants (with only a very poor root system). A bigger peat volume has a (slight) positive influence on production.

Autumn crop in a plastic tunnel (Wilhelminadorp and Geldermalsen)

In Wilhelminadorp (PFW) for the second year it was attempted to elongate the harvest period of primocane fruiting raspberries, using young canes of different age. So, with Zefa Herbsternte as well as with Autumn Bliss not only 3 canes per pot were grown, but also 2 canes followed later by a third one, and 1 cane followed by a second and sometime later a third one. It appeared difficult to get good quality canes later in the season. Therefore, the treatments did not result in a somewhat lower production, while a longer harvest season was hardly obtained.

In Geldermalsen with the same cultivars 3-year-old plant material was compared with plants that were divided into several parts after 2 seasons, and with new canes. In all treatments 3 canes were grown per pot, and 3 pots were placed per meter row. On 8 July all pots were placed in a tunnel. Specially grown and thereafter cold-stored plants of Glen Clova and Glen Moy were used

Table 63. Results with a culture of potted primocane fruiting raspberries for more than one year.

Treatments	Kg/m ²		% 1 st quality	Average fruit weight (g)	Mean harvest date
	1 st qual.	Total			
Zefa Herbsternte					
3 years old	1.71	2.18	21	6.1	22 September
divided plants	1.61	2.09	23	6.0	6 October
new plant material	1.37	1.73	21	6.3	1 October
Autumn Bliss					
3 years old	2.22	2.74	20	4.9	8 September
divided plants	1.68	2.21	24	4.8	14 September
new material	2.13	2.62	19	4.8	6 September
Glen Clova	0.23	0.46	50	4.8	8 October
Glen Moy	0.67	0.90	25	5.7	8 October

as comparisons (planted on 8 July).

The results, summarized in Table 63, show that with Zefa Herbsternte 3-year-old plants and divided plants gave a higher yield than the new ones. However, with Autumn Bliss the divided plants gave lower production. The cold-stored plants gave very disappointing results.

It is clear that primocane fruiting raspberry plants can be grown for at least 3 years in the same pot. In general, the primocane fruiting cultivars give more reliable results than cold-stored plants of summer-cropping raspberries. However, primocane fruiting raspberries have a much longer harvest season than the summer-cropping cultivars.

Blackberry

An early crop in a plastic tunnel (Geldermalsen)

In order to get an early harvest sometimes blackberry plants are grown in pots. An investigation was made to see if the same plants can be used continuously for a number of years. New plants of Bedford Giant were compared with plants that were already used in 1991 or in 1990 and 1991. Also, plants were used that produced fruit in 1990 and after that were pruned back, so that there was no crop in 1991. Plants were grown in 20-l pots, with 2.5 plants per m².

From the figures in Table 64 it is clear that the plants that gave no yield in 1991 gave the highest production in 1992. Furthermore, plants used for an early crop in 1991 gave a higher yield in 1992 than those that were used for a late crop in 1991. Older plants were at least as productive as the new plants. So, potted blackberry plants can be used certainly for 3 successive years. However, the harvest period is rather late (in 1992, 15 June - 31 July), that makes it impossible to grow 2 blackberry crops in 1 year.

Table 64. Results of an early crop with the blackberry cultivar Bedford Giant.

Treatment*	Kg/m ²		% 1 st quality	Average fruit weight (g)
	1 st qual.	Total		
Early crop in 1991	3.25	4.24	23	4.0
Late crop in 1991	2.88	3.72	23	3.9
1990 + early crop 1991	3.47	4.35	20	3.9
1990 + late crop 1991	3.03	4.03	25	3.8
1990. no crop in 1991	3.61	4.59	21	3.8
New plant material	2.93	3.73	21	3.9

* Plants in 1990 partly used for an early, partly for a late crop (cold-stored plants).

A late crop with cold-stored plants in a plastic tunnel (Geldermalsen)

With cold-stored plants for a late crop new plants were compared with plants that had already produced fruits in 1991 and with plants that produced fruits in 1990 and gave no yield in 1991. All plants were put in a tunnel on the 9 July.

Development was only moderate as was the production (1.5 to 1.9 kg/m²). Compared with 1991 this was rather disappointing. Because interest in this

production method is very limited, trials will not be continued in 1993.

Red currant

An early crop with red currants in containers (Geldermalsen)

In 1990 plants of Jonkheer van Tets and Junifer, potted in 10-l-containers, were raised with 2 branches inside a plastic tunnel, outdoor or partly inside and partly outdoors. In 1991 and 1992 all plants were grown in the containers in a plastic tunnel at a distance of 2 x 0.5 m.

In 1991 Jonkheer van Tets gave almost no yield. However, Junifer gave plenty of flowers on 1-year-old wood. As a result of this the plants raised indoors and the plants that were raised indoors until mid-June produced 2 kg/m². Due to severe fruit drop only 1 kg/m² was first quality fruit. Plants that were raised outdoors during the whole season or during the first part of the season only produced 0.6-0.8 kg/m² with about 70 % first quality fruits.

For Junifer, in 1992 production of all treatments was about the same (Table 65). Again the percentage of first quality fruits was lowest for the plants raised indoors or raised indoors for the first part of the 1990 growing season.

With Jonkheer van Tets total yield varied from 1.8 to 2.3 kg/m², with about 75 % always first quality.

The preliminary conclusion is that for an early crop red currants can be grown in pots very well. During the first years Junifer gave much better results than Jonkheer van Tets. From the point of view of costs and because of the fruit quality the best method seems to be raise the plants outdoors for the first year. However, with Junifer this causes production to suffer in the first year.

Table 65. Production and fruit quality in 1992 (plants grown differently in their first year - 1990).

Growing method in 1990	Junifer			Jonkheer van Tets		
	Kg/m ²	% 1 st qual.	Berries/truss	Kg/m ²	% 1 st qual.	Berries/truss
In a tunnel	4.1	50	8.1	2.1	77	9.5
First inside, later outdoors	4.1	70	10.2	2.0	73	9.4
Outdoors	3.9	50	8.9	2.3	75	9.6
First outdoors, later inside	4.2	70	9.1	1.8	74	10.2

Blueberry (Horst)

Spreading of the harvest period

By using a mobile tunnel it was attempted to get an extra spread of the harvest period of blueberries. In 1992 with early ripening cultivars in a mobile tunnel the harvest period was advanced by 2 to 3 weeks. In July the tunnel was placed over late ripening cultivars. Because the fruits could be left on the bushes somewhat longer, then the picking period was delayed by 1 to 2 weeks. Because of this the total harvest season was elongated from 6 - 8 weeks to 10 - 12 weeks.

CULTIVAR TRIALS OF BUSH AND CANE FRUITS

A.A. van Oosten

Red currant

First screening of new cultivars and selections

Most results of previous years were confirmed. In the winter of 1984/'85 11 cultivars were planted. After the 1992 harvest the following varieties were compared: Junifer, 1967, Cassa, Roodneus and Augustus. The trial with Red Start is finished. This variety has weak growth, the fruits are small and the production is low. From the varieties planted in 1988, the varieties Northern, Jotum and Fortun are still in trial. The results are not hopeful.

Selections of Rondon

The problems with Rondon J are not yet solved. The best Rondon selections in this trial are Rondon G5 and Rondon H (see also Annual Report 1991).

Pink currant

Again Rosa Sport was the best pink currant (see also Annual Report 1991). Although it was more sensitive to leafspot than Soeur de Claire.

White currant

Cultivar trial

The trial with the varieties Zitavia, Werdavia, Albatros, Witte Parel,

Table 66. Results of a cultivar trial with white currant.

	5 % flowers	Harvest date	Kg/ m ²	100 berry weight (g)	Average tross weight (g)	Number of berries/ tross
	1986 - 1992			1986 - 1991		
Zitavia	2 April	4 July	3.99	72	7.0	10.1
Werdavia	5 April	5 July	2.67	67	7.0	10.9
Albatros	6 April	9 July	1.91	55	5.5	10.0
Weisse Jüterbog	8 April	12 July	1.05	62	6.4	10.4
Witte Parel	6 April	12 July	1.95	66	6.6	10.0
Primus	7 April	22 July	3.94	55	6.8	12.4
Blanka	12 April	2 August	4.15	67	9.4	14.3

Altogether one can say that the new cultivars are a significant improvement of the white currant assortment.

Weisse Jüterbog, Primus and Blanka is finished. Zitavia is the best early ripening variety. Werdavia is also early ripening but the fruit quality is somewhat inferior to Zitavia. The growth of Albatros is moderate. The fruit quality is very good. The standard variety Witte Parel was in every way lower than the new varieties. The results with Weisse Jüterbog were also bad. Primus

was very productive as was Blanka. Fruit of Primus is small. Blanka is the latest ripening variety. Zitavia, Albatros and Blanka are recommended.

Black currant

Preliminary screening of new cultivars and selections

The results of the varieties planted in 1988 agree with last year. In 1992 the production of all varieties was very high. In 1993 the varieties and selections Burga, Ceres (76/69), Otelo, selection K.W. Leandra, Triton, Titania, Phoenix, Ben Sarek, Tsema and Black Reward are in trial.

In 1991 Andega, Troll, Ben Tirran, Ben Alder, ECM, Eva and Viola were planted. Andega, Eva and Viola grow upright and strong. Andega and ECM had no mildew. Troll, Eva and Viola are sensitive to mildew (see also Annual Report 1991).

Gooseberry

Preliminary screening of new cultivars and selections

In 1992 a number of cultivars were in trial. Invicta, May Duke, Greenfinch, Goudbal, Starfructa Dunkelrot, Golda, Rosko, EM 1815/133, EM 1815/123 and EM 1815/125. The EM selections have only a few thorns and they have slightly hairy and bright red fruits. They are not sensitive to mildew.

Black currant x gooseberry hybrids

Jocheline, Jochina, Jostine and Jogrande look like Josta but the fruits are bigger.

Raspberry

Preliminary screening of new cultivars and selections in the open

After the 1992 harvest the trial will be continued with Ru 74, Gradina, Skeena, Comox, Sel. Eversdijk, Glen Coe, Meeker, Rutrago, Rumiloba, Malling Augusta. The trial with Balder, Nootka, Chilliwach and Titan was finished for different reasons:

Balder : berries rather small and soft; plants are infected with virus.
Nootka : berries rather small.
Chilliwach : berries rather small.
Titan : plant infected with *Phytophthora fragariae*.

Cultivar trial in a plastic tunnel

The varieties Glen Moy, Glen Clova, Skeena, Veten and Gradina were in trial
Skeena : firm fruit, nice colour but somewhat too small fruit.
Veten : berry colour too dark, rather small fruit and moderate taste.

Cultivar trial with primocane raspberries

The results of previous years were confirmed. In trial were the varieties Zefa Herbsternte, Autumn Bliss, Heritage and Polana (see also Annual Report 1991) were compared; plants were potted (2 plants/7.2-1 pot) in February 1992. The pots were put in a tunnel. The plant material of Autumn Bliss was new and 1 year old; that of Heritage and Polana 2 years old. There were not enough

plants of Zefa Herbsternte, that is why a new start was necessary with new material. The results are given in Table 68.

Table 67. Results of a trial with raspberry cultivars grown in a plastic tunnel 1992.

	Kg/m ² 1 st and 2 nd quality	% 1 st quality	Average berry weight (g)	Dates on which the following % were picked		
				5 %	50 %	95 %
Glen Clova	3.16	88	3.4	20 May	30 May	19 June
Glen Moy	1.83	87	4.1	26 May	5 June	22 June
Veten	1.68	91	4.1	31 May	9 June	26 June
Skeena	1.34	93	3.9	29 May	12 June	27 June
Gradina	3.10	88	4.3	3 June	16 June	1 July

Table 68. Results of a cultivar trial with primocane ripening raspberries.

	Kg/m ² 1 st and 2 nd quality	% 1 st quality	Average berry weight (g)	Dates on which the following % were picked		
				5 %	50 %	95 %
Autumn Bliss new plants	1.98	90	4.7	2 August	31 August	12 Oct.
Autumn Bliss 2-year-old plants	1.90	87	4.7	8 August	9 Sept.	20 Oct.
Zefa Herbsternte 1-year-old plants	1.63	85	5.8	16 August	17 Sept.	28 Oct.
Polana (81-221) 1-year-old plants	1.36	86	4.3	26 August	22 Sept.	31 Oct.
Heritage 1-year-old plants	1.27	88	3.8	24 August	29 Sept.	4 Nov.

Cultivar trial with cold-stored raspberry plants

In trial were the varieties Glen Clova, Glen Moy, Malling Exploit, Rode Radboud, Meeker, Marwé, Schönnemann and Gradina.

Productive varieties with more than 2.00 kg per m² were Glen Moy, Malling Exploit, Marwé and Schönnemann. The varieties with fruit smaller than 4.0 g per berry were Glen Clova, Rode Radboud and Meeker.

Blackberry

Preliminary screening of new cultivars and selections

In 1992 11 varieties were in trial. The results were the same as last year (see Annual Report 1991). The trial with Fantasia is finished because this variety is strongly thorned.

Blueberry

Cultivar trial in a plastic tunnel

In the trial started in March 1990 with Patriot and Bluecrop, planted in 12-l containers in a plastic tunnel, Patriot again gave the best results.

At the beginning of March 1992 10 varieties were planted, also in 12-l containers in a plastic tunnel. These were the varieties Bluechip, Bluetta, Spartan, Patriot, Bluejay, Collins, Earlyblue, Duke, Reka and Nui.

Table 69. Results of a cultivar trial with blueberry in a plastic tunnel.

Cultivar	1992	1990 - 1992			
	kg/m ² 1 st quality	kg/m ² 1 st quality	% 1 st quality	100 berry weight (g)	Mean harvest date (50 %)
Patriot	2.69	2.11	96	169	21 June
Bluecrop	1.25	1.18	93	137	27 June

DISEASE-FREE PLANT PROPAGATION OF STRAWBERRIES AND OTHER SMALL FRUITS

J. Dijkstra and J. de Bruijn

Strawberry

Unrooted cuttings: planting dates and storage. (Wilhelminadorp)

The influence of dates for taking unrooted cuttings and the size of the cuttings on plant quality was investigated. It was also checked to see if unrooted cuttings can be stored for several weeks (at 1 °C) before planting. The aim was to get more homogeneous plant material. All mother plants were grown in peat bags on scaffoldings.

Cuttings were taken at 22 July, 4 and 18 August and 2 September. At the dates in July and August half of the cuttings were put directly into small pots and the other half were cold-stored until 2 September and then planted together with the cuttings that were taken at that date. Cuttings were divided into the following groups: small (only 1 unfolded leaf), intermediate 2-3 unfolded leaves) and large (3-5 unfolded leaves). The cuttings were grown under mist for about 2 weeks and thereafter raised in a plastic tunnel with glasshouse sprinklers. For nearly all treatments 100 % of the cuttings rooted. However, small cuttings that were cold stored for 4 to 6 weeks gave 5-10 % drop outs.

On 16 December the rhizome diameter of all plants was measured and the plants were put into cold storage (-2 °C). From the figures in Table 70 it is clear that the earlier the cuttings were taken, the bigger the plants were. Cuttings that were stored for 2 to 4 weeks gave as large plants as cuttings planted directly on 2 September. However, cuttings stored for 6 weeks stayed somewhat behind. The earliest taken cuttings showed some premature flowering.

It appears that homogeneity can be improved if intermediate large cuttings are stored for about 2 weeks and large cuttings for about 4 weeks. However, this is at the cost of plant size.

Table 70. Diameters of the rhizomes of unrooted cuttings planted on different dates, measured on 16 December 1992.

Cutting dates	Size of the cuttings			
	Small	Intermediate	Big	Average
22 July, directly planted	12.4	14.9	14.5	14.0
4 Aug., directly planted	11.7	12.8	13.9	12.8
18 Aug., directly planted	11.0	11.5	13.2	11.9
2 Sep., directly planted	10.0	11.5	12.0	11.2
2 Sep., after 2 weeks cold storage	9.8	11.2	11.9	11.0
2 Sep., after 4 weeks cold storage	9.6	11.3	12.8	11.2
2 Sep., after 6 weeks cold storage	8.6	10.3	11.3	10.1

The influence of the treatments on flower initiation and production will be investigated in 1993.

Influencing runner and runner plant production. (Wilhelminadorp)

Homogeneity and plant size are important for a good culture. Therefore, an investigation was made to see if by manipulation of runner formation homogeneity and plant size could be influenced positively. In one treatment the first runners per mother plant were removed; with other mother plants runners were pruned in different ways.

All operations resulted in a decrease in the number of young plants per mother plant and only the removal of the first runners led to an increase in the average plant size. Because of the great negative influence on runner plant numbers the used methods of manipulation of the runner formation are not practicable to increase the homogeneity.

Planting dates and raising of the cuttings inside or outdoors. (Breda)

At the experimental station in Breda mother plants in peat bags were planted outdoors on scaffoldings at the end of March. Cuttings were taken at 13, 21 and 29 July, 4, 13, 20 and 28 August and 4, 14, 21 and 28 September. Up to and including 4 September cuttings were raised outdoors, from 4 August onwards cuttings were also raised in a glasshouse.

In December 1992 the plants that were grown outdoors appeared to be better than those that were grown in the glasshouse. The first planting date gave the strongest plants. All plants that were grown indoors showed premature flowering in December; the plants that were grown outdoors did not. A provisional conclusion is that cuttings that will be raised outdoors have to be taken before 1 August. If cuttings are grown in a glasshouse they can be taken about 1 month later. The effect of the treatments on production and fruit quality will be established in 1993.

Lifting dates for cold storage. (Breda)

With cuttings raised in trays outdoors as well as with those raised indoors an investigation was made to see what is the best lifting date to put the plants into cold storage. With plants grown outdoors weekly lifting dates from 12 November until 24 December are compared. With plants grown indoors lifting dates go from 10 December until 21 January.

Until now, the impression is that plants that were grown in trays outdoors

can be cold-stored earlier than plants grown in the soil. Definitive results will be obtained in 1993.

Raspberry

Propagation by way of root cuttings. (Wilhelminadorp)

As with strawberries plant health is very important in raspberries. It is investigated to see if there is a real possibility for raspberry plant propagation from root cuttings. In a first trial the influence of size and diameter of the root cuttings on the percentage of developing canes was investigated.

Roots of Glen Clova were pulled up at the beginning of March and directly planted in square 9-cm-pots. Root length varied from 2 to 6 cm, root diameter varied from 2 to 4 mm. The proportional results after 6 weeks are given in Table 71. The percentage of developed shoots depended on root diameter as well as on root length. Propagation took place under rather primitive circumstances. In December cane length was 130 - 150 cm but the canes were very thin, probably because pots used were too small.

Table 71. Percentage of developed shoots from the root cuttings after 6 weeks.

Diameter of the roots	Length of the root cuttings		
	2 cm	4 cm	6 cm
2 mm	7	28	44
3 mm	28	44	69
4 mm	48	65	74

OPTIMIZING CLOSED GROWING SYSTEMS IN STRAWBERRY CULTURE

J. Dijkstra and J. de Bruijn

Growing strawberries in closed systems, comparison of plant material and different substrates

Research on closed growing systems is carried out at the experimental station in Breda. In an early (heated) culture of Elsanta, plants in buckets with peat were compared with plants in rockwool and with plants on a nutrient film technique system (n.f.t.). Drainage water was recirculated without disinfection, but there were no problems with diseases. The results are summarized in Table 72.

Plants on rockwool stayed somewhat smaller during the waiting bed period. Also growth of these plants in the glasshouse was insufficient. Probably the rockwool blocks stayed too wet.

Although plants raised in buckets at the waiting bed were quite big, production and fruit quality were disappointing. However, plants grown on a normal waiting bed and later in buckets gave a good production, but with a moderate quality.

In n.f.t. the normal waiting bed plants showed many nutrient deficiencies. EC and pH quickly reached high levels in this system, so that the nutrient

solution had to be corrected often to get the target levels (EC: 1.5 and pH: 5.5). Also in n.f.t. plants in rockwool pots were too small. Therefore, production stayed low. The so-called tray plants were big enough, but only gave a reasonable production of moderate quality.

The conclusion is that a normal waiting bed, followed by a culture in buckets gave the best results. The other growing systems have to be improved quite a bit.

Table 72. Results with closed growing systems in an early glasshouse crop of Elsanta.

Treatment		Kg/m ² total	% 2 nd quality	Average* fruit weight (g)
Waiting bed	Glasshouse			
Outdoors in rockwool	- in rockwool pot	3.6	10	14.3
Outdoors in buckets	- in buckets	3.3	22	13.9
Outdoors in soil	- in buckets	4.7	24	13.0
Outdoors in soil	- n.f.t.	3.6	29	11.8
Outdoors in rockwool	- rockwool pot in n.f.t.	2.7	15	13.5
Glasshouse in tray	- peat pot in n.f.t.	3.9	29	12.0
Glasshouse in tray	- in buckets	3.4	34	15.6

* only first quality fruits

ECONOMICS AND FARM MANAGEMENT ANALYSIS

INTERNATIONAL POSITION OF THE DUTCH PEAR INDUSTRY

J. Goedegebure and M.J. Groot

In continuation of the study of the international position of the Dutch apple industry (annual report 1989) a study of the international position of the Dutch pear industry was started in 1992. The study is focused on Conference, the most important Dutch cultivar.

From the EC agricultural surveys of 1987 and 1992 the development of the pear acreage in the most important production areas will be analyzed. Also estimations of future trends in the acreage and the production per region and per cultivar will be made. In this project the computermodel developed for the apple project, will be used. The model is already adapted for pears. It was not yet possible to make a start with the estimation of future trends, because the data from the agricultural surveys are not yet available.

In addition to the future trends of acreage and production, the project will also analyse the costs of production and marketing. Therefore an inquiry will be held at fruit holdings in the most important production areas of the EC.

The Central Bureau of Fruit and Vegetables Auctions in The Netherlands will analyse the future trends in the market. This part of the project will also, in addition to a general part, be focused on Conference. The expectation is that the results of the research are available at the end of the year 1993.

DEPARTMENT OF PLANT NUTRITION AND FRUIT
QUALITY

PHYSIOLOGY

LATERAL SHOOT FORMATION IN YOUNG FRUIT TREES IN THE NURSERY PHASE

J. Tromp and S.J. Wertheim

Lateral shoot formation in apple in the first year after budding as affected by air temperature and exposure to red light - J. Tromp

As a continuation of previous experiments where the attention was focused on air humidity and soil temperature (Annual Report 1990, p. 70 and 1991, p. 82) in a new experiment, the effect of air temperature on tree development was evaluated. Trees of cvs Elstar and Rode Boskoop in their first year after budding were exposed to 3 temperatures, i.e. 16 °C, 21 °C and 26 °C (day and night) throughout the growing season. In an additional treatment the 21 °C-regime was combined with exposure to red light of low intensity (wave length 660 nm) on every hour for 10 mins during the night. In each treatment the vapour pressure deficit of the air was about 0.40 kPa, and day length 14 h. Soil temperature was 17 °C.

As Table 73 shows for both cultivars, increasing air temperature from 16 °C to 21 °C especially favoured lateral shoot growth but also favoured growth of the main shoot. At 16 °C lateral growth was very poor or almost completely lacking. A further increase to 26 °C stimulated growth of mainly the terminal shoot in Boskoop and only lateral growth in Elstar.

Table 73. Effect of air temperature and exposure to red light (R) on growth of Elstar and Rode Boskoop in the first year after budding.

Air temperature (°C)	Growth/tree (cm)			Number of laterals/ tree*
	total	main shoot	lateral shoots	
Elstar				
16	81	78	3	0.2
21	310	107	203	7.3
21 + R	314	104	210	7.7
26	423	110	313	5.6
Rode Boskoop				
16	97	81	16	0.7
21	261	120	141	4.5
21 + R	279	117	162	4.9
26	315	132	183	5.2

* Lateral shoots > 10 cm and inserted above node 10 from the graft-union.

In Boskoop number and length of shoots that satisfy the requirements of practical fruit growing (length > 10 cm, inserted above node 10 from the graft union, or about 40 cm above soil level) except for the situation at 16 °C, hardly responded to temperature. In Elstar fewer lateral shoots may have occurred at 26 °C than at 21 °C, but it can be calculated that shoot length increased with temperature. Addition of red light had no effect.

Flower-cluster counts done in the following spring showed that the number of flower clusters of good quality (having more than 4 well-developed flowers) decreased markedly with increasing temperature (Table 74). The value found for Boskoop for lateral shoots at 16 °C refers only to a few shoots and, therefore, is not very reliable. Red light had no effect on the number of high quality clusters.

Table 74. Effect of air temperature and exposure to red light (R) on the number of flower clusters with more than 4 well-developed flowers formed on the main shoot and the lateral shoots of Elstar and Rode Boskoop in the first year after budding.

Air temperature (°C)	Elstar		Rode Boskoop	
	main shoot	lateral shoots	main shoot	lateral shoots
16	4.4	-	4.9	0.4
21	1.1	2.3	2.1	4.6
21 + R	1.2	2.6	2.7	6.1
26	0.2	0.2	0.2	2.2

Lateral shoot formation in apple as affected by air humidity and different day/night temperatures - J. Tromp

In another experiment, also carried out with Elstar and Rode Boskoop, at low as well as at high air humidity 2 temperature regimes were compared, i.e. day/night 20 °C/20 °C and 23 °C/16 °C. Soil temperature was 17 °C; day length was 14 h.

A few data for Elstar are shown in Table 78. As found before (Annual Report 1990, p. 70) high air humidity favoured total growth. This increase was mainly reflected in lateral shoot growth; growth of the main shoot responded little. Growth was much stronger at 23 °C/16 °C than at 20 °C/20 °C. Again this

Table 78. Effect of air humidity and day/night temperature on growth of Elstar in the first year after budding.

Air humidity	Day/night temperature (°C)	Growth/tree (cm)			Number of laterals/tree*
		total	main shoot	lateral shoots	
Low	20/20	143	90	53	1.3
High	20/20	184	94	90	2.9
Low	23/16	257	99	158	5.2
High	23/16	409	113	296	8.1

* Lateral shoots > 10 cm and inserted above node 10 from the graft-union.

response mainly concerned lateral growth. It can be calculated that mean length per shoot did not differ much between treatments. As a consequence, the humidity and temperature treatments mainly influenced the process of shoot emergence and hardly affected subsequent growth.

The effect of hormones in the nursery - S.J. Wertheim

All trials in 1992 were made in co-operation with E. Estabrooks, guest worker from the Agriculture Canada Research Station at Fredericton, New Brunswick, Canada.

In a nursery at Wolphaartsdijk the effect of repeated sprays of benzyladenine (BA) on growing buds of Red Boskoop on M.9 was investigated. Budding was done in August 1991 on M.9 rootstocks planted at 100 x 30 cm. The treatments are given in Table 75 and were replicated 10 times with 1 tree per plot.

Table 75. Results branching trial 92.0.221.

Treatment ppm BA	Bud length (cm)	Trunk dia- meter (mm)	Laterals/tree			Average length (cm)	
			< 10 cm	> 10 cm	zone 50-90 cm* > 10 cm	all later- als	laterals in zone 50-90 cm*
Control	145	16	4.1	4.0	1.1	19	17
Promalin	141	16	2.3	6.7	4.0	22	17
4 x 50	141	16	3.7	4.4	1.0	25	27
8 x 50	140	15	3.4	4.8	1.8	24	19
4 x 100	138	16	2.3	6.4	2.0	20	22
8 x 100	140	16	2.7	8.5	4.2	24	21
4 x 200	134	16	2.6	9.0	4.4	17	14
8 x 200	140	16	5.3	10.6	6.3	18	17
4 x 400	136	17	2.7	11.2	6.4	19	18
8 x 400	140	17	3.5	14.5	9.1	17	16
LSD (P = 0.05)	6	n.s.		2.5	1.4	n.s.	6

* Zone from 50 till 90 cm above the ground. n.s. = non significant.

BA was applied 4 or 8 times in concentrations of 50, 100, 200, or 400 ppm. Tween 20 at 0.1 % was added in each spray as a wetter. The first BA spray was made on 9 June when the trees were on average 51 cm long, measured from the ground. The other sprays followed at weekly intervals. The last spray was carried out on 29 July at 122 cm crop height. The buds grew on average 1.4 cm per day during this period. Untreated buds and buds sprayed with Promalin (50 ml/l water) at 65 cm height - current practice - served as controls.

Table 75 shows that Promalin had a reasonable effect on lateral shoot formation, especially when the zone 50 - 90 cm above the ground is considered.

This is the zone where frame branches should develop. The untreated control shows how poorly Red Boskoop normally feathers if not forced one way or another. BA at 50 ppm had no effect, but from 100 ppm BA became active, the more so the higher the concentration. Eight sprays of 400 ppm BA produced most shoots (Photo 1). The extra shoot formation did not affect the growth of the main stem, in length or in diameter. It appears that the most active treatments also increased the formation of buds along the laterals. All trees have been planted in an orchard for further evaluation.

In 2 trials in a commercial nursery at Steenberg the effect of combined or separate applications of benzyladenine (BA) and gibberellins A₄+A₇ (GA₄+7) was studied. Current practice is to spray once with Promalin, an equal mixture of BA and GA₄+7, thus to use a combined spray of 2 hormones. American work shows that a separate application: BA followed by GA₄+7 might be more effective (HortScience 23(1988)5:859-862). To evaluate this finding the treatments mentioned in Table 76 were carried out on Red Boskoop and Golden Delicious "Reinders", both on M.9 rootstock. A wetter (0.1 % Citowett) was added to all sprays. Spraying was confined to the upper 15 cm of the growing

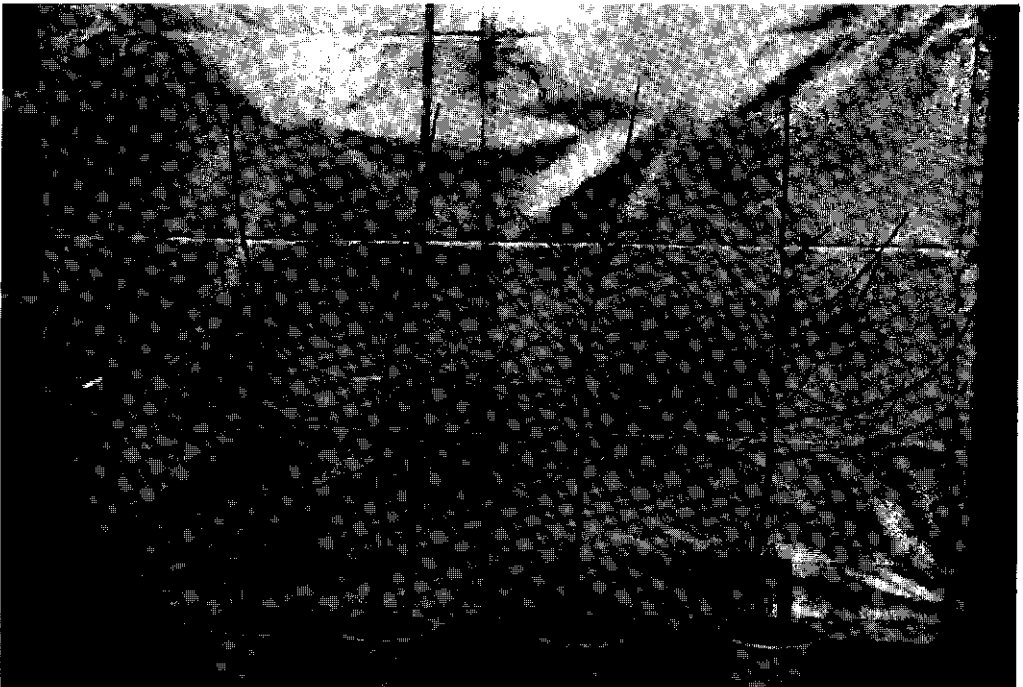


Photo 1. One-year-old buds of Red Boskoop on M.9. From left to right: untreated and treated with 8 x 50, 8 x 100, 8 x 200, or 8 x 400 ppm BA (see text). Trees from nursery, but put in containers for photo.

buds. The first spray fell on 23 June when Boskoop buds were 54 cm and those of Reinders 49 cm (measured from the union, which was 15 cm above soil level). The second and third sprays were made on 7 and 20 July. Concentrations used were 1,000 ppm in all cases, also for the Promalin components.

Promalin favoured lateral-shoot formation, especially the early treatment on 23 June. On 7 July Promalin induced more shoots only on Reinders. Two applications were much more effective than one, which may be of interest for the industry. BA was less active than Promalin, but here again 2 sprays gave more laterals than 1. GA₄₊₇ was more effective than BA when applied at the same time, but with Reinders this was so on both dates, with Boskoop only after the spray on 23 June. With Reinders 2 sprays were better than 1, but not with Boskoop. A split application of BA and GA₄₊₇ had good effects, too, but 2 split applications were not significantly better than 1. The LSD values in Table 76 can be used to distinguish between the various treatments. Late GA₄₊₇ sprays were not very effective, but again 2 were better than 1. None of the treatments proved detrimental for bud length or stem diameter (data not given).

Table 76. Results branching trial 92.0.226.

Treatment	Data*			Golden Delicious "Reinders"			Red Boskoop "Schmitz Hübisch"		
	1	2	3	-----			-----		
				Bud length (cm)	Laterals/tree		Bud length (cm)	Laterals/tree	
					< 10 cm	> 10 cm		< 10 cm	> 10 cm
Untreated				125	3.0	2.8	138	4.5	4.2
Promalin	+			121	1.3	7.0	129	2.4	9.1
Promalin		+		126	5.1	7.3	133	5.5	5.8
Promalin	+	+		126	1.5	12.1	130	2.1	12.0
BA	+			120	2.0	5.8	123	3.4	5.8
BA		+		117	5.6	3.6	125	3.2	7.8
BA	+	+		120	4.9	6.8	122	2.5	9.4
GA ₄₊₇	+			129	2.0	8.9	120	2.4	10.0
GA ₄₊₇		+		131	3.4	7.0	134	5.1	4.5
GA ₄₊₇	+	+		135	2.9	12.2	130	3.4	8.0
BA(GA ₄₊₇)	+	**		137	3.9	9.8	123	3.5	8.8
BA(GA ₄₊₇)		+	**	132	4.8	7.3	134	4.0	10.0
BA(GA ₄₊₇)	+	***	***	133	3.1	10.9	133	2.2	11.0
GA ₄₊₇		+		128	4.9	5.3	134	3.8	6.1
GA ₄₊₇			+	132	3.4	2.3	133	3.5	6.2
GA ₄₊₇		+	+	142	4.9	8.3	134	3.2	7.8
LSD (P = 0.05)				7	1.7	2.4	n.s.	2.1	3.0

* 1 - 23 June, 2 - 7 July, 3 - 20 July.

** GA₄₊₇ spraying date.

n.s. = non significant.

The trials show that both components of Promalin induced lateral shoot formation, GA₄₊₇ more so than BA, and further that repeated applications are better than a single spray. A split application can be effective, too.

In a trial at a nursery at Nispen the effect of smearing BA, GA₄₊₇ or Promalin in a carrier (Topsin-M paste) on buds of Red Boskoop on M.9 was investigated. Concentrations were 500, 1,000 and 2,000 ppm, also in the case of the Promalin components. The trees were 1 year old and cut back at 90 cm height. On 14 April, when buds showed some green tissue, 6 to 7 buds in the zone 65 - 85 cm were treated with a brush. In the trial the effect of scoring was also studied; a cut was made with a small saw blade just above the bud.

This penetrated into the bark as far as the wood. This was done to isolate the bud from any auxin that descends from the growing tip. Scoring was done within the same zone 65 - 85 cm. All regulator treatments were made with and without scoring. Completely untreated trees served as controls, as well as trees sprayed once with Promalin (50 ml/l).

Most buds grew out well. In untreated trees 5.2 per zone without scoring and 6.5 with scoring. Averaged for all regulator treatments these figures were 5.7 and 6.2. Scoring also enhanced growth: the average shoot length increased from 38 to 47 cm. The chemical treatments had little or no effect. Spraying Promalin and smearing BA had no effect at all, GA₄₊₇ and Promalin had a slight positive effect both on the number of growing buds and on the shoot length. The effects were too small to be of practical value.

In a nursery at Steenberghe the effect of smearing thidiazuron (TDZ) on growing tips of Red Boskoop buds on M.9 was studied. The treatments summarized in Table 77 were taken in 8 replications with 1 tree per plot. Concentrations used were 0.1 and 0.2 % of 50 % trade product. A zone of 20 cm was treated beginning 10 cm below the tip in a downward direction. Treatments were made on 7 and 23 July and on 19 August, when the buds measured 79, 101, and 115 cm

Table 77. Results TDZ trial 92.0.225.

Treatment		Con- centra- tion (%)	Bud length (cm)	Trunk dia- meter (mm)	Laterals/tree		
Plant height (cm)	Treated zone cm above soil				< 10 cm	> 10 cm	total
Untreated	-	-	111	12	0.1	0.0	0.1
79	50-70	0.1	109	12	0.9	0.1	1.0
101	70-90	0.1	111	13	1.6	0.4	2.0
79+101	50-90	0.1	111	13	1.0	0.1	1.1
115	90-110	0.1	114	13	1.5	0.3	1.8
101+115	70-110	0.1	108	13	1.6	0.9	2.5
79+101+115	50-110	0.1	118	13	0.9	0.0	0.9
79	50-70	0.2	113	12	0.4	0.0	0.4
101	70-90	0.2	111	13	0.1	0.1	0.2
79+101	50-90	0.2	117	13	0.8	0.3	1.1
115	90-110	0.2	108	13	1.6	0.4	2.0
101+115	70-110	0.2	111	13	3.9	0.9	4.8
79+101+115	50-110	0.2	109	12	0.0	0.0	0.0

from the soil respectively. Treated zones were 50 - 70, 70 - 90, or 90 - 110 cm. Some trees were treated 2 or 3 times, but the application each time was on a non-treated zone.

Table 77 shows that the treatments did not have much effect. Two treatments (on 23 July and 19 August) had some effect, but when these were preceded by a treatment on 7 July, there was no effect whatsoever, which is strange. Treating bud tips with TDZ in the way done in this trial is, therefore, not an effective way of inducing lateral shoots.

FRUIT RIPENING AS AFFECTED BY ENVIRONMENTAL FACTORS DURING THE GROWING SEASON

J. Tromp

The effect of various temperature regimes during the growing season on fruit ripening in apple

Since experimental data on the effect of weather conditions during the growing season on fruit ripening are scarce, in a preliminary experiment 3-year-old potted trees of Cox's Orange Pippin were exposed to 8 day-temperature regimes, i.e. 12 °C/16 °C (first 8 weeks after full bloom/rest of season), 16 °C/16 °C, 20 °C/16 °C, 24 °C/16 °C, 12 °C/24 °C, 16 °C/24 °C, 20 °C/24 °C and 24 °C/24 °C. Night temperature was 4 °C lower throughout; day length was 14 h. The remaining conditions were equal in all treatments. Dependent on the available amounts of fruits per treatment, starting at 100 days after full bloom for 8 weeks, samples of 10 fruits each were taken weekly and kept at 20 °C for about 30 days. Starting at harvest, every 8-12 days thereafter fruit colour (Minolta chromameter) and ethylene production were measured for each individual fruit. In addition, in co-operation with the Institute for Agro-Technological Research in Wageningen, photofluorescence measurements were done. All samples will be analysed for Ca, Mg and K.

A few preliminary results are:

- Fruit set was greatly affected by the various treatments. In most treatments the number of fruits did not permit weekly sampling.
- The temperature during the first 8 weeks after full bloom may have affected fruit ground colour to some degree (shift from green to yellow).
- Temperature later in the season had little influence on fruit ground colour
- Until about 5 weeks after the first date of picking fruit ground colour was hardly affected by time of picking. Thereafter the effect increased, especially when temperature was high at the beginning of the growing season.

STORAGE AND QUALITY

PREDICTION OF OPTIMUM HARVEST DATE FOR LONG TERM STORAGE IN APPLE AND PEAR

A. de Jager and F.P.P.M. Roelofs

Aims and methods

The aims of this project were to investigate the possibility of predicting

the optimum picking date with regard to the planning of picking and storage i.e. 7-10 days ahead.

Two different methods were carried out at the same time. In the first product parameters were measured regularly from about one month before the start of the picking period until the end. Since combinations of parameters are considered particular good predictors of optimum harvest date this method is called the **index method**. In the second approach, the **meteo method**, the possible correlation was studied between growing period of the fruit and weather conditions. In both methods the actual optimum harvest date was determined after storage comparing measured and tasted quality of fruit of different picking dates. Detailed information on the experimental set up has been given already in the report on 1989.

In this report we pay attention to the following aspects:

1. Prediction of harvest date of Jonagold by the index method
2. Prediction of harvest date of Conference by the index method and solely by firmness
3. Prediction of harvest date of Cox's Orange Pippin by the meteo method
4. Loss of firmness in Elstar and Cox's Orange Pippin from orchard to consumer

Reported data mostly refer to experiments started in 1991 with fruit stored until a given date in the first half of 1992.

Prediction of optimum harvest date of Jonagold

The aim of this research is to develop a method of predicting of the optimum harvest date of Jonagold (and Conference, see next section) based on the harvest index according to Streif. This index is calculated as

$$\frac{\text{firmness}}{\text{refraction} * \text{starch pattern}}$$

(see reports for 1990 and 1991)

Figure 4. Time dependence of the harvest index according to Streif in Jonagold for 1989, 1990 and 1991.

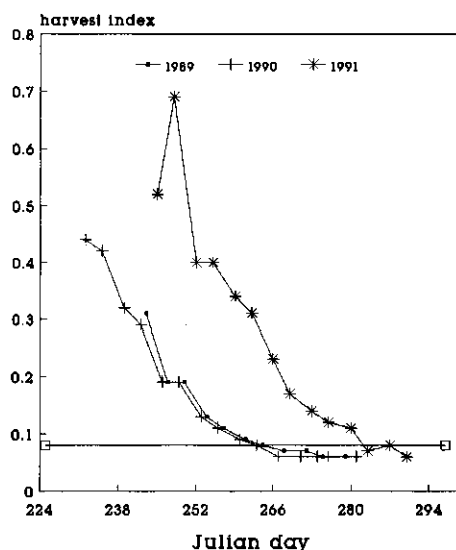


Figure 4 shows the time dependence of the mean harvest index of Jonagold for 1989, 1990 and 1991. Apparently the form of these curves is almost identical in the 3 years. Based on these curves we have been giving the following information.

To auctions and extension services on the number of days ahead or behind the situation in 1990 and 1989 comparing identical index values. Assuming that a reasonably good idea exists about harvest dates in the previous years, a new estimate can be made for the current year. Table 79 shows the time pattern of

Table 79. Number of days in 1991 ahead or behind 1989 and 1990 for Jonagold comparing identical values of the harvest index.

Years	1990 - 1989	1991 - 1990	1991 - 1989
Julian day			
245	2	-	-
252	2	19	-
259	1	20	17
266	3	20	18
273	-	21	20
280	-	22	21
287	-	24	21

these predictions. Apparently 1989 and 1990 were very similar and 1991 was about 3 weeks behind these years.

The identical pattern of the curves - also when considering individual orchards - suggests that a common mathematical formula might be found to describe these curves. The following formula has been found on the basis of 32 orchards over the 3 years:

$$(1) \quad \ln(\text{index}) = a + b \cdot d \quad R^2 = 93 \%$$

where a and b are known constants characteristic for each orchard and d is Julian day number.

Table 80. Mean value of the harvest index (with standard deviation of the mean) at optimum harvest date according to calculated quality (firmness, sugar, acid) or taste as a criterium. Values are multiplied by 10^{-2} .

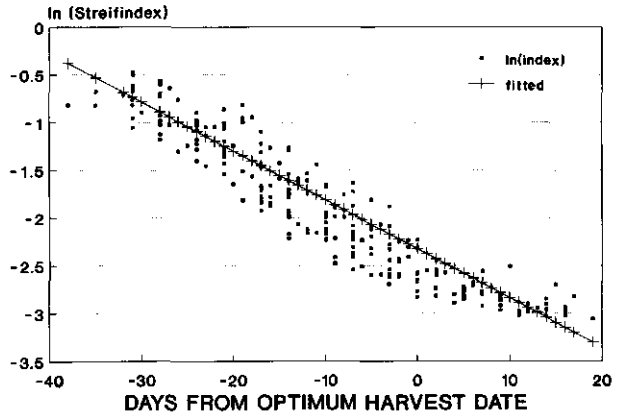
Year	1989	1990	1991	1989 - 1991
formula				
replicates	12 (12)	12 (6)	8 (4)	32 (22)
calculated	9.1 (0.4)	9.2 (0.5)	12.1 (0.8)	9.9 (0.4)
calculated*	9.1 (0.4)	7.2 (1.3)	12.2 (1.2)	9.6 (0.4)
tasted	5.7 (0.5)	9.1 (1.0)	5.5 (1.7)	6.6 (0.6)

* Calculating method for the same orchards for which also the taste test has.

For each of the 32 orchards the optimum harvest date has been established comparing the 4 different harvests with respect to taste, firmness, sugar content, acid content and % diseased. This date can be fed into the formula in

order to calculate the corresponding value of the harvest index. Table 80 shows the mean harvest index at optimum harvest date according to the combination of firmness, sugar and acid and the harvest index solely according to taste. Using taste as a criterium gives a lower optimum harvest index at a later optimum harvest date. As a compromise we can use a value of $8 (* 10^{-2})$. Apparently the optimum harvest index is not independent of the year. It seems that in late years we should pick at a higher value of the harvest index. Analysis of this effect showed that this effect can be incorporated into the predicting system.

Figure 5. Relationship between normalized time and $\ln(\text{Streifindex})$ for all 32 orchards in the years 1989, 1990 and 1991 with $t=0$ at OHD and OHD determined by function (1) according to calculated quality after long storage and 2 weeks of shelf life (function (2)).



In order to predict ODH a common relationship has to be found between time and value of the Streif index. This has been done by setting OHD for each orchard to day zero (normalizing the time axis). Figure 5 shows the result for all 32 orchards. The formula for this relationship ($\ln(\text{index}) = -2.3 - 0.051 * \text{daynumber}$) shows a R^2 of 87 %. Now a reversal of this function describes the normalized time as a function of the index value:

$$\text{dn} = -40.2 - 16.9 * \ln(\text{index}) \quad R^2 = 86 \%$$

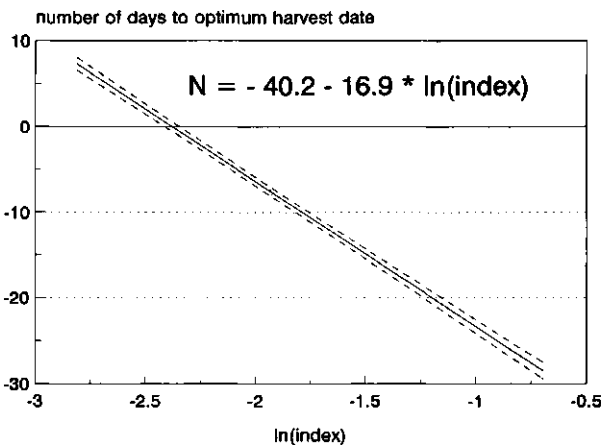


Figure 6. Reversal of the relationship in Figure 5 with the 95 % confidence interval for the mean (prediction for a group of 32 orchards).

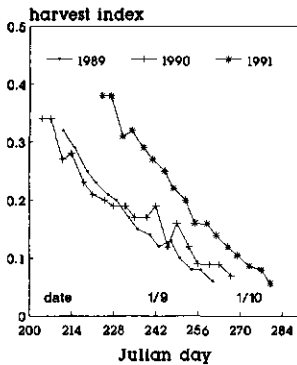
The method presented here can be applied by any fruit grower or extension specialist by first doing a few rather simple measurements (firmness, refraction, starch pattern), calculating the harvest index and reading from Figure 6 the number of days to optimum harvest date. Of course additional data may cause minor improvements in the method and also automation will be possible for those growers already in possession of a computer.

Prediction of the optimum harvest date of Conference

The methods used in the research on optimum harvest date in Conference are basically identical to those in Jonagold and are also described in the reports for 1989 and 1990.

A predictive formula for optimum harvest date of Conference will probably be available in the early summer of 1993. Because we conclude from our data that firmness is a better predictor than the index according to Streif, we show both parameters in the following tables and figures. Figure 7 shows the time dependence of the harvest index and of firmness alone. Data are based on 7 to 8 orchards in 3 subsequent years (total 23). From the figures we may conclude that both harvest index and firmness show similar curves in the subsequent years. Based on these curves we have been informing - as we did in the case of e.g. Jonagold - auctions and extension services about the number of days ahead or behind the situation in previous years at identical values of the harvest index. Table 81 shows this information. As in the case of Jonagold, 1989 and 1990 are very similar years whereas the year 1991 was much later. Comparing harvest index and firmness we see that, using firmness; the differences are more constant in time than using the index. This already indicates that firmness might be a better parameter to predict harvest date.

Harvest Index Conference



Firmness Conference

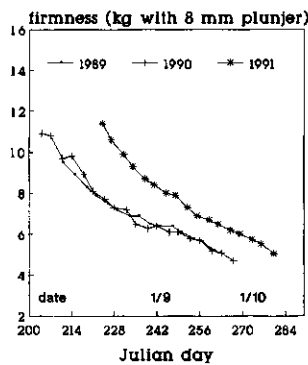


Figure 7. Time dependence of the harvest index according to Streif (left) and the firmness (right), measured with a 8 mm plunger in 1989, 1990 and 1991.

Fruits from 4 subsequent harvest dates (one week apart from each other) were stored at standard conditions. After storage we recorded quality (firmness, sugars and taste) and the number of diseased fruits (especially brown heart). Based on these observations the optimum harvest date was determined for each orchard as well as the value of the harvest index and of the firmness at that date. Table 82 shows the mean optimum harvest index and the mean optimum firmness for harvesting Conference pears on the basis of the results of the 3 years. The relatively high value of the harvest index at the optimum harvest date in 1990 is a consequence of the occurrence of brown heart in relatively early picked fruits. So, from Table 82 it appears that

Table 81. The number of days earlier or later than previous years comparing identical values of the harvest index and firmness.

Years parameter	1990 - 1989		1991 - 1990		1991 - 1989	
	index	firmn.	index	firmn.	index	firmn.
Julian day						
214	-5	2	-	-	-	-
221	-2	3	-	-	-	-
228	-1	2	-	-	24	20
235	2	0	23	24	27	20
242	4	0	24	24	27	20
249	7	0	24	23	25	22
256	8	0	23	22	20	23
263	8	0	22	17	16	23
270	-	-	20	17	13	19
277	-	-	18	18	9	19

- on the basis of data from 3 years - the firmness is a better predictor of optimum harvest date than the harvest index. At the same time the coefficient of variation is much smaller for firmness. So, for the present, our best advice is to pick at a firmness of 5.9 kg measured with the 8 mm plunger. In order to predict this moment the decline of firmness will be recorded in the same way as the harvest index for Jonagold.

Table 82. Mean value of the harvest index (with standard deviation of the mean) and of the firmness, and the variation coefficient (% varco) at optimum harvest using the occurrence of brown heart and taste as criteria. Values of the index and the variation coefficient are multiplied by 10^{-2} .

Year	1989	1990	1991	1989 - 1991
n	8	7	8	23
Harvest index	9.1 (1.0)	13.5 (1.1)	9.1 (0.9)	10.5 (0.7)
Varco (%)	29.7	23.0	27.5	31.4
Firmness	5.9 (0.1)	6.0 (0.2)	5.7 (0.2)	5.9 (0.01)
Varco (%)	6.8	6.7	8.9	6.8

Prediction of the optimum harvest date for Cox's Orange Pippin apples using a fitted meteorological model

Several methods have been developed to estimate the optimum harvest date (OHD) of apples. Some of these methods are based on human expertise (e.g. Washington Stage Apple Maturity Program) some are semi-quantitative, like the T-stage method by Stoll and some try to describe the relationship between fruit parameters and time or between the development period and meteorological

data. These relationships could then be used as a model to predict OHD. A meteorological model would offer the advantage of a relatively simple method e.g. by growers who have a weather recording station and a PC at their disposal. On the other hand setting up a model requires, relatively, a lot of time. In 1990 we described the first results of a model. This report describes the fitting of harvest date of Cox's Orange Pippin to date of full bloom, temperature and precipitation for a period of 18 years at one location.

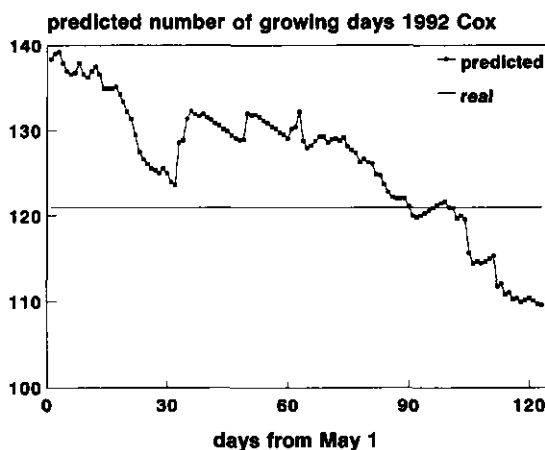
Data of full bloom (FB), temperature, precipitation and OHD for the variety Cox's Orange Pippin, collected at the location Wilhelminadorp for a period of nearly 20 years, were used to fit a model of OHD. Data of temperature (mean, maximum, minimum) and precipitation were available on a daily basis. The data refer to trees of 4 years of age and older that are part of a variety trial. The decision on when to pick the fruits was taken each year by the scientific officer in charge. Fitting was executed in stages by the so-called R-select method. Mean 24 hours temperature and daily precipitation were introduced on a monthly basis. Introducing more variables increased the % variance accounted for, but also increased the complexity of the formula.

The following relationships have been found:

- (1) $ND = -0.838 FB + 166.1$
% variance accounted for 40.8 % (adjusted $R^2 = 37.1$ %)
- (2) $ND = -1.033 FB - 0.1518 DIF (May) + 211.8$
% variance accounted for 61.7 % (adjusted $R^2 = 56.6$ %)
- (3) $ND = -1.219 FB - 0.1602 PR (May, June, July, August) + 0.3059 PR (June)$
- $0.2262 DIF (May) - 0.2044 DIF (July) + 305.5$
% variance accounted for 82.5 % (adjusted $R^2 = 72.9$ %)

where ND = number of days from Full Bloom to OHD
FB = days from 1 April to Full Bloom
PR = average of daily precipitation
DIF = average of difference between maximum and minimum temperature

Figure 8. Prediction of the optimum harvest date of Cox's Orange Pippin in 1992 as a function of time according to formula 3 at the location Wilhelminadorp based on 18 years of data.



All formulae predict a smaller number of growing days with a later date of flowering. The behaviour determined from equation (3) for the dataset of the growing season of 1992 in relation to the actual weather is demonstrated in Figure 8. The prediction is based on using the standard data set (mean for the 18 years used to fit the model) and replacing the standard data by the actual data on a daily basis.

Formula 3 predicts that an increase in the day-night difference in temperature and precipitation, both decrease the number of growing days. In addition precipitation in June increases the number of growing days! The further decrease at the end of the growing period, in which large amounts of precipitation occurred, might point to overemphasis of this factor.

Loss of firmness in Cox's Orange Pippin in Elstar and in Jonagold

Firmness of apples is considered at the present time to be the most important quality factor. During the final 6 weeks in the orchard, firmness will decrease steadily but also during storage firmness will decrease to a greater or lesser extent, depending on variety and storage conditions. In addition, firmness will decrease at first slowly and later on rapidly during shelf life. Decisions concerning harvest date, duration of storage period, length of selling period and conditions at the latter phase could be improved if we could predict loss of firmness at the different stages.

For the past 3 years we have been collecting a lot of data on firmness in the context of research into optimum harvest date. By now sufficient data are available to calculate the mean loss of firmness of the 3 varieties Cox's Orange Pippin, Elstar and Jonagold from a variety of orchards applying normal harvest dates, modern storage conditions and a shelf life of 1 week at 10 °C followed by 1 week at 20 °C.

Experimental details

At 4 harvest dates (too early, too late and twice in between) fruits were picked for long storage. During a period of 4 weeks preceding the first pick samples of 25 fruits were collected from different orchards in order to measure a number of parameters, including firmness, with an INSTRON using the 11 mm probe. Apples were stored in small indirectly cooled containers in years 1 and 2 and in larger directly cooled stores in year 3. The main difference between both storage methods lies in the higher RH at indirect cooling. Table 83 shows the storage conditions used. For Jonagold we chose to increase the CO₂ concentration from 3 or 4 to 5 %. This affected firmness slightly positively compared with the lower CO₂ concentrations. In our experiments long storage means to the end of February for Cox's Orange Pippin, to the beginning of April for Elstar, and to the end of May for Jonagold. After storage fruits are exposed for one week to 10 °C followed by one week at 20 °C. The first week simulates trading and the second week simulates the table phase.

Table 83. Storage conditions.

	Temperature (°C)	% O ₂	% CO ₂
Cox's Orange Pippin	4	1.2	0.5
Elstar	1	1.2	2.0
Jonagold	1	1.2	5.0

Results

Table 84 shows the decrease in firmness (kg per day) for the 3 varieties as a mean for each period and for the 4 harvest dates. So, at a decrease of 0.087 kg per day for Cox's Orange Pippin, each week of delay in picking means a loss of 0.6 kg.

Some important conclusions:

1. Cox's Orange Pippin apples lose firmness more quickly than Elstar and Jonagold apples, in the orchard as well as during storage. During storage the rate of loss is as much as four times higher than Elstar.
2. Loss of firmness during shelf life is much less during the first week in Elstar and Jonagold than in the second week. In Jonagold this is even close to zero! In Cox's Orange Pippin differences between week 1 and week 2 of shelf life are less pronounced.
3. Different years show a different picture. In Cox's Orange Pippin and Elstar the rate of loss of firmness in week 1 is much higher in year 1 than in the other years and in week 2 it is much lower. What we see here is that the rate of loss of firmness slows down as it approaches a sort of temporary minimum around 3 kg before firmness is lost completely. If this level is almost reached in week 1, then little loss will occur in week 2.

Table 84. Rate of loss of firmness as kg per day in the years 1989 - 1990, 1990 - 1991 and 1991 - 1992 for Cox's Orange Pippin, Elstar and Jonagold as a mean for the 4 different harvest dates.

	Orchard	Storage	Shelf life	
			week 1 10 °C	week 2 20 °C
<u>Cox's Orange Pippin</u>				
1989 - 1990	0.076	0.016	0.105	0.000
1990 - 1991	0.082	0.016	0.050	0.125
1991 - 1992	0.095	0.014	0.044	0.154
1992 - 1993	0.096			
average	0.087	0.015	0.066	0.093
<u>Elstar</u>				
1989 - 1990	0.055	0.006	0.190	0.099
1990 - 1991	0.061	0.002	0.014	0.289
1991 - 1992	0.069	0.004	0.017	0.277
1992 - 1993	0.051			
average	0.059	0.004	0.074	0.222
<u>Jonagold</u>				
1989 - 1990	0.056	0.006	-0.005	0.136
1990 - 1991	0.048	0.002	0.064	0.209
1991 - 1992	0.058	0.003	-0.010	0.134
1992 - 1993	0.050			
average	0.053	0.004	0.016	0.160

These data agree with the experience that Elstar may lose firmness rather quickly during shelf life and that Jonagold, on the other hand, has an extended shelf-life period.

Effect of harvest date

In general the advantage of a higher firmness as a consequence of harvesting earlier is lost for the greater part in Jonagold and almost completely in Cox's Orange Pippin and Elstar during the second week of shelf life.

Example

Despite the differences between years and the effect of harvest date, it may be possible to do some calculations in order to predict the results which would follow the various choices.

Example 1

Suppose we wish to export Cox's Orange Pippin to England on 15 January at a firmness of at least 6 kg. When harvesting on 15 September the loss of firmness during storage is $121 * 0.015 = 1.8$ kg. So, assuming the fruit is stored immediately after harvest the firmness at harvest should be at least 8 kg. The longer the period between harvesting and closing the storage cell, the higher the required firmness at harvest (say a loss of 0.3 kg per week).

Example 2

Suppose we wish to offer the consumer Elstar apples on 15 April (after 1 week of trading period) that still have a firmness of 4.5 kg after 3 days at 20 °C. The loss of firmness, when harvesting at 15 September is estimated as $202 * 0.004 + 7 * 0.074 + 3 * 0.222 = 2.0$. So, firmness at harvest should be at least 6.4. Also this only applies when the storage cell is closed very soon after harvesting the fruit.

PREDICTION OF THE RISK OF SCALD IN SENSITIVE VARIETIES

A. de Jager, M. Awad and F.P.M.M. Roelofs

Aims and approaches

The aim of this project is to study the possibility of predicting the risk of scald in Jonagold before and at harvest, as well as during storage. Research is being done along two lines, (1) a study of the influence of temperature in the orchard and (2) a study of the level of oxidants and antioxidants, both in relation to the actual appearance of scald.

Prediction of the risk of scald before harvest allows for the adapting of harvest date and condition and duration of storage. Prediction of the risk of scald during storage may affect duration of storage and speed of marketing.

In 1991 2 experiments were started with Jonagold that were completed in June 1992 after 8 months of storage. Experiment 1 has been combined with the experiment described in the report on storage conditions (page 93). An essential feature of the set up is that fruit is collected from 8 growers, where the occurrence of scald differs from "never" to "always". Here fruit has

been picked on different dates and stored at different conditions. In experiment 2 trees have been covered on cool nights by different materials (plastic, aluminium foil and a combination of both) to create a range of night temperatures.

Effect of night temperature

According to the literature the incidence of scald decreases with an increasing number of hours below 10 °C (or 12 °C). This agrees more or less with the experience that scald may appear especially in years with a warm month before harvest where colouring is also retarded. Results of experiment 1 do not show a relation between number of hours below 10 °C and scald in 1991. In experiment 2 we found a positive correlation ($R = 0.67$) between the number of hours below 10 °C and the level of antioxidants but scald did not occur.

Effect of harvest date and storage condition

Figure 9 shows that after 6 months of storage at 1.3 % O_2 the concentration of conjugated triene hydroperoxides (CTH) is lower and the concentration of

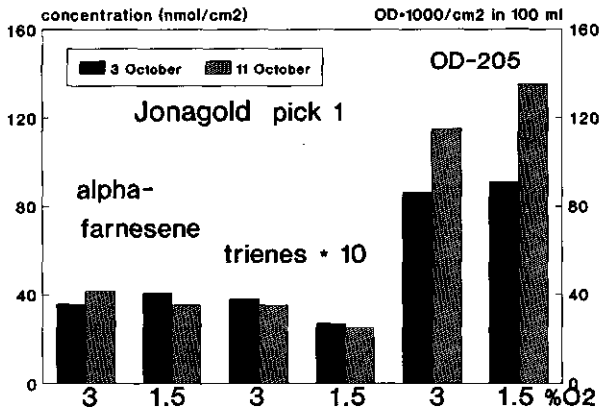
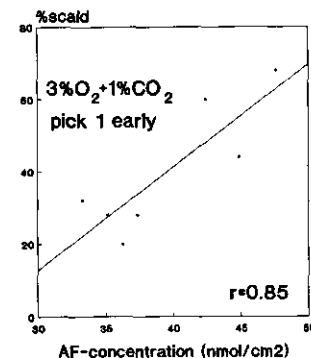


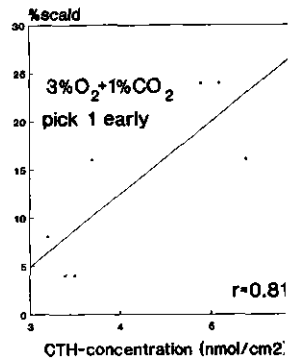
Figure 9. The concentration of antioxidants (OD-205) and oxidants (AF and CTH) in the skin of Jonagold at 2 different O_2 concentrations during storage (1.3 % and 3 %) and 2 harvest dates (early and normal) after 6 months of storage.

Figure 10. The relation between the level of AF and CTH after 6 months of storage and the incidence of scald after 2 weeks of shelf life of Jonagold apples stored at scald favouring conditions (3 % O_2 and 1 % CO_2).

AF (alpha-farnesene) and %scald



CTH (triènes) and %scald



antioxidants (OD-205) is higher than at 3 % O_2 . At that time early picked fruits (pick 1) show a slightly higher CTH level and a much lower OD-205 level. These observations are in accordance with the much lower incidence of scald (virtual absence) in ULO and the higher incidence of scald at an early harvest date. The level of Alpha-farnesene (AF) is not affected. Figure 10 shows a good correlation between the occurrence of scald at different growers and the level of AF and CTH after 6 months of storage.

Conclusions after 1 year

1. The concentration of AF is very low at harvest and rises continuously during storage. Variation in the incidence of scald between growers is explained rather well by the level of AF after storage. Harvest date and storage conditions seem to have little influence on the level of AF. AF has no predicting value at harvest.
2. The concentration of CTH after storage seems to be rather well correlated with harvest date and storage conditions and shows a good correlation with the incidence of scald. The earlier pick and the higher O_2 level show a higher level of CTH. CTH has no predicting value at harvest.
3. The level of antioxidants (OD-205) at harvest is higher at a later harvest date and at a lower O_2 level during storage and is rather well (negatively) correlated with the incidence of scald after storage and shelf life. OD-205 values at harvest might have a predictive value.

Since low oxygen (ULO) and high carbondioxide seem to control the incidence of scald very effectively a prediction of the risk of scald is especially useful for CA conditions and normal cooling as far as Jonagold is concerned. A prediction might be also important in the case of Boskoop since high CO_2 concentrations in storage cannot be applied in the case of this variety.

OPTIMUM STORAGE CONDITIONS AND ABILITY TO USE STORAGE TECHNIQUES ON POME FRUIT

F.P.M.M. Roelofs, E.A. van Hermon and A. Scholtens

Storage research at Wilhelminadorp

In 1992 research was carried out to determine the optimum storage conditions for new apple and pear varieties. Results of the research with the apple varieties Elise, Gala, Rafzubin and Fiesta and the pear varieties Condo, Concorde, CPRO 66006-273 and Dolacom (better known as JI 7451), are described below.

Elise can be stored until the end of December in regular storage at 1 °C. On the other hand with CA and ULO conditions (1.2 % O_2 and 5 % CO_2) the fruits can be stored until April. There was little loss of firmness during storage and shelf-life tests. Elise appears not to be sensitive for high CO_2 damage until 5 % CO_2 (brown core). Only a few apples from some orchards had a brown core after long storage under these conditions. Fruits which were picked early had a bad taste.

The quality of Gala apples stored below zero was no better than apples stored at +1 °C. Gala appears not to be sensitive for high CO₂ damage until 5 % CO₂. Loss of firmness during storage and shelf-life tests was relatively high, especially after long storage (April).

Fiesta can be stored as Cox's Orange Pippin, at 4 °C, 1.2 % O₂ and < 0.5 % CO₂ until the beginning of April.

In February, firmness of Rafzubin, stored at 4 °C, 1.2 % O₂ and < 0.5 % CO₂ decreased to 5 Kg/cm². Fruits were not juicy in taste tests after a shelf life of 1 week at 10 °C and another week at 20 °C. At that time a high percentage of the fruits was over-stored. Fruits stored at a lower temperature had low-temperature-damage (browning of the fruit flesh).

In March "brown-core" was found in the pear varieties CPRO 66006-273 and Dolacomí. Pears stored under ULO conditions (2 % O₂ and 0.7 % CO₂) at +1.0 °C were all sensitive to internal browning. ULO-stored Dolocami pears at +0.5 °C were also sensitive.

Until April, Concorde stored well in regular storage (-0.5 °C). Even after long storage Concorde was still firm and crisp.

CA-stored (-0.5 °C, 2 % O₂ and 0.8 % CO₂) Condo from one orchard had brown-heart pears, special late picked fruits. Condo stored at -1.5 °C suffered injury due to freezing. In time picked Condo stored well until May.

Storage research at regional experimental orchards

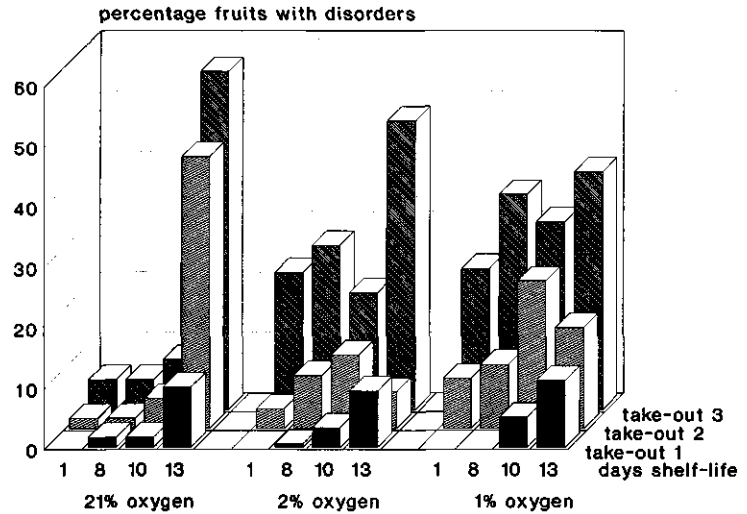
At Numansdorp research was started on the effect of oxygen, carbon dioxide, temperature, picking time and crop-load on storage period of Doyenné du Comice. All fruits came from one orchard where trees with a high crop-load (HC) were picked separately from trees with low crop-load (LC). LC trees were picked on 30 September and 13 October. HC trees were picked on 6 October and 13 October. On 6 October LC fruits were bigger and less starch had disappeared. At that same date TSS and titratable acid was at a higher level. Temperatures varied between -1.5 and -0.5 °C. At both temperatures regular storage and combinations of 1 and 2 % oxygen with 0.2, 0.7 and 2.0 % carbon dioxide were examined.

Fruits stored at -1.5 °C had much freezing injury, independent of oxygen and carbon dioxide levels. After storage LC fruits were as firm, but less green, than HC fruits. Differences of TSS and titratable acid did not disappear. In almost all samples internal browning appeared in the core after long storage or during shelf life (Figure 11). The first take-out took place on 7 January, the second on 19 February and the third on 11 March 1992. The quality of the samples was recorded after take-out, after 1 week at 10 °C, after another 2 days at 20 °C and after another 3 days at 20 °C.

At Geldermalsen research was continued on the effect of oxygen and carbon dioxide to reduce scald in Jonagold. Fruits from 8 growers were stored at controlled atmospheric conditions: (a) 1.3 % and 1.0 %, (b) 1.3 % and 5.0 %, (c) 3.0 % and 1.0 % and (d) 3.0 % oxygen and 5.0 % carbon dioxide and all at 1.0 °C. The orchards varied in type of soil. All growers had meteorological equipment. At all locations meteorological data were collected to examine the relationship between night temperatures during the last 6 weeks before picking and the occurrence of scald (see also page 92).

In addition to the normal first and second pick through on 3 October and

Figure 11. Percentage in- and external diseases as an average of the different carbon dioxide levels (0.2, 0.7 and 2.0 %) on oxygen directly after storage and during shelf life.



10 October, an early first and second pick (in spot picking system) was done 1 week earlier to increase the risk of scald. For normal pick at least 33 % of the fruits had to be coloured. The fruits were cooled as soon as possible after picking. The oxygen level was decreased by using liquid Nitrogen.

On 5 April 1992 samples of each plot were taken from the storage rooms for quality control (rated for scald, storage losses and shelf life). On 25 May 1992 fruits were taken out for final quality control. Losses in fruit weight were measured during storage. Later the fruits were sorted. Quality control was based upon single fruit weight, colour (L,a,b-value; Minolta Chromameter), firmness (Kg/cm²; Instron), TSS (% Brix), acid content (% malic-acid) and ratings of external and internal diseases. After 1 week shelf life at 20 °C the fruit quality was measured again. Another group of samples was observed for 4 weeks at 20 °C for the appearance of scald.

Table 85. Percentage of fruits with scald immediately following 6 and 8 months of storage and after another 7 days at 20 °C in 1991 and 1992.

Storage condition	after 6 months		after 8 months	
	*	**	*	**
1,3 % O ₂ - 1 % CO ₂	1,19 a-a	3,57 a-a	1,79 a-a	5,60 b-b
3,0 % O ₂ - 1 % CO ₂	0,48 a-a	2,86 a-a	3,47 a-b	20,24 c-c
1,3 % O ₂ - 5 % CO ₂	0,12 a-a	0,24 a-a	0,00 a-a	0,00 a-a
3,0 % O ₂ - 5 % CO ₂	0,17 a-a	1,07 a-a	1,43 a-a	1,79 a-a

* immediately after storage.

** after 1 week shelf life at 20 °C.

Different letters in the first column mean vertical statistical reliable differences at (P < 0.05), different letters in the second column mean horizontal differences.

The increase of CO₂ had the greatest influence on the appearance of scald.

Also reduction of the oxygen level had an effect. As last year, the combination of 1.3 % oxygen and 5 % carbon dioxide was the most effective in suppressing scald. Even after 8 months of storage and 1 week shelf life at 20 °C, no scald was observed (Table 85). This combination was also the most effective to reduce loss of firmness (Table 86).

Table 86. Firmness in Kg/cm² immediately following 6 and 8 months of storage and after another 7 days at 20 °C in 1991 and 1992.

Storage condition	After 6 months		After 8 months	
	*	**	*	**
1,3 % O ₂ - 1 % CO ₂	5,87 b-a	5,68 b-b	5,72 b-ab	5,40 b-c
3,0 % O ₂ - 1 % CO ₂	4,60 a-a	4,50 a-ab	4,42 a-bc	4,30 a-bc
1,3 % O ₂ - 5 % CO ₂	6,48 b-a	6,09 b-bc	6,22 b-b	5,87 b-d
3,0 % O ₂ - 5 % CO ₂	6,14 b-a	5,72 b-b	6,00 b-a	5,61 b-b

* Immediately after storage.

** After 1 week shelf life at 20 °C.

Different letters in the first column mean vertical statistical reliable differences at (P < 0.05), different letters in the second column mean horizontal differences.

The research will be repeated in 1992 and 1993.

OPTIMUM STORAGE CONDITIONS AND ABILITY TO USE STORAGE TECHNIQUES ON SOFT FRUIT

F.P.M.M. Roelofs and L. Schreinemachers

Red currant

In 1992 research continued on the effect of picking date, oxygen and carbon dioxide concentration on the storability of 5 varieties of red currants. The conditions which were studied were combinations of 0, 10, 20 and 30 % carbon dioxide with low oxygen concentration (2 %) or oxygen concentration not regulated (17-21 %). All currants were stored at 1 °C. The 4 weekly picking dates were spread over the normal picking period of the individual variety. The first pick of Rotet took place in week 29, of Rondon and Rovada in week 30, of Roodneus in week 31 and of Augustus in week 32. Fruits of the second pick were used to examine the effect of storage conditions on storability. The effect of picking time on storability was examined at 2 % oxygen and 20 % carbon dioxide.

Samples of each plot were assessed for quality directly after storage and after 4 days at 18 °C in week 40, 43, 46, 49 and week 2 (January 1993). Quality was assessed directly after storage (Figure 12 continuous line) and after 4 days shelf life at 18 °C (Table 12 discontinuous line). At each second assessment there was a taste test and viscosity of pulp and TSS, titratable acid and pH of the juice was measured.

Almost 40 % of the fruits stored in regular storage were rotten at the

first take-out in week 40. Three weeks later there was a lot of decay (20 %) in the samples stored at 2 % oxygen with 0 % carbon dioxide. In week 2, (after 23 weeks of storage!) there were less than 10 % rotten fruits in the plots with 20 and 30 % carbon dioxide. In week 43 carbon dioxide damage was found in plots with 30 % carbon dioxide. These fruits were coloured pink and had an awful taste. The different varieties differed in sensitivity to carbon dioxide damage. Rondon and Rotet were the most sensitive, Rovada was less sensitive and Roodneus and Augustus were relatively unaffected.

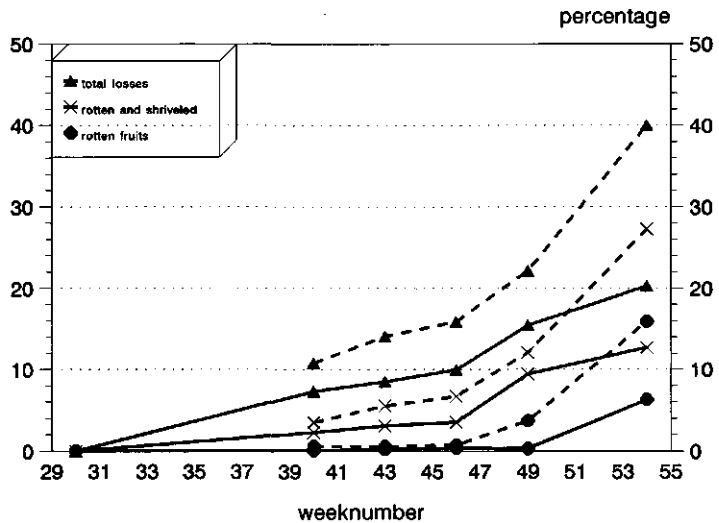
Storage conditions had a great effect on viscosity. Pulp of currants stored at high-carbon dioxide concentrations had low viscosity, especially in combinations with low oxygen concentrations. Storage period had an influence on viscosity. After centrifugation of the pulp there were 3 parts: 1)pits/gel, 2)juice and 3)the rest. Storage conditions had an effect on the proportions of the different parts. It was noticeable that plots with low viscosity had a low percentage of juice. In taste tests, these plots were described as juicy.

After long storage (from week 46) there were more rotten fruits in the plots of pick 1. In week 2 of 1993 8 % of the currants of pick 1 and 3 % of the currants of pick 4 were rotten. Late picked fruits were more sensitive to shrivelling. In week 2, 8 % of the currants of pick 4 and 4 % of the currants of pick 1 were shrivelled. After storage the avg. TSS-values of pick 1 were 13 % and avg. TSS-values of pick 4 were 14.5 %.

Until week 43 there were no differences in rotten fruits between the varieties. At the end of the experiment Augustus and Roodneus had the least rotten fruits in the plots. Augustus and Rondon were most sensitive to shrivelling, Roodneus was most resistant.

In 1993 particular attention will be paid to storage temperature, carbon dioxide damage and picking time.

Figure 12. Development of decay during storage at 2 % oxygen and 20 % carbon dioxide.



Plum

In 1992 research was carried out to examine the effect of combinations of 0, 4 and 7 % carbon dioxide with 3 and 18 % oxygen on storability of Victoria plums. The plums were stored at -0.5 and +0.5 °C. Plums from 2 growers, picked at 3 stages of ripeness, were stored for 2 to 4 weeks. Group 1 were plums for the next pick, with a stem, not totally coloured, hardly no softening and the

stone mainly connected to the fruit flesh. Group 2 and 3 (with and without stem) were plums for the direct consumption market, almost totally coloured, softening started and the stone partly connected to the fruit flesh. After storage and during a shelf life of 2 and 4 days at 18 °C firmness, colour, weight loss, TSS and titratable acid were measured. Also physiological and microbiological diseases were observed.

Plums stored at -0.5 °C had more loss of weight. Plums stored at 3 % oxygen had a better taste and were less changed in colour. High carbon dioxide levels retarded the change of colour and losses of firmness and acid. After 2 weeks there was 18 % decay, after 3 weeks 32 % and after 4 weeks 42 % decay. Plums without stem lost more weight than plums with stem. Weight loss rose from 1.3 % after 2 weeks of storage to 1.7 % after 4 weeks of storage. Plums without stem (group 3) had 46 % decay, plums with stem (group 1 and 3) had resp. 16 and 32 % decay. In taste tests plums of group 1 were judged 4.9, group 3 was better (5.4) and plums of group 2 were best (6.2). Research will be continued.

SOIL SCIENCE AND PLANT NUTRITION

THE EFFECT OF FERTIGATION ON GROWTH AND FRUIT PRODUCTION IN APPLE AND PEAR

M.P. van der Maas and P.J. Bolding

Fertigation on apple

Fertigation and timing

The experiment in which the effect of period of fertigation was studied was terminated in 1992. Table 87 shows the results of the last season. In 1992 the

Table 87. The effect of period of fertigation on the yield of Summerred and Elstar.

Variety/ treatment*	Yield per tree (kg)				
	1989	1990	1991	1992	Total
Elstar					
A	7.3	5.1	22.6	21.8	56.8
B	5.2	7.5	21.4	25.2	59.4
C	5.6	9.1	19.4	26.1	60.2
D	6.2	10.8	19.3	23.6	59.8
Summerred					
A	3.6	8.8	15.6	18.0	46.0
B	2.8	8.1	16.5	17.4	44.8
C	3.0	8.3	16.1	16.8	45.2
D	3.0	9.4	15.2	18.2	45.8

* A: fertigation from mid-April to mid-June

B: idem from mid-June to mid-August (when normally growth ceases)

C: idem in September

D: idem in October (following harvest)

- outside these periods water has been supplied according to requirement

- per treatment 20 gram of N has been supplied

number of flower buds in Summerred was lowest in the second fertigation period (B), possibly as a consequence of a slightly stronger tree growth. Fertigation in October unexpectedly led to the highest fruit yield, though at a lower mean fruit weight. The average for 4 experimental years, however, reveals no consistent differences between treatments. In Elstar the estimated number of flower buds and the yield were highest in 1992 with treatment B. Comparing the 4 experimental years for Elstar there is a tendency towards a slightly lower yield in treatment A. Statistical analysis still has to be performed.

CONTROL OF GROWTH AND PRODUCTION OF PIT AND STONE FRUIT BY WATER AND NUTRIENT SUPPLY

M.P. van der Maas and P.J. Bolding

Water application according to requirement

In 1992 an experiment has been started in which meteorological variables are measured automatically (precipitation, irradiation and temperature) and used as a basis for calculating the potential transpiration of the orchard. The system has been tested in an orchard with 4-year-old trees of Discovery and Jonagold at a density of 2000 and 4000 trees per hectare. The trees are fertigated with 19-6-6 at a rate of 0.5 gram per litre and the amount of applied solution is governed solely by the water requirement. The effect of this scheme on the water content of the soil has been measured a number of times using TDR measurements. These measurements showed that the level of available water in the rooted zone was kept almost constant by this model-guided supply of solution.

At the experimental garden of Horst the water content of the soil was monitored with a system of constant fertigation (daily 2 l). Measurements at different distances from the point of supply showed on the one hand that situations of overwetting can easily arise and on the other hand that considerable losses of water directly from soil to air may occur. This illustrates the need for a guiding model as described above.

Artificial substrates

In order to study the possibilities of controlling growth and yield by nutrition an experiment has been started with Jonagold trees (planted on 22 May) grown in containers with gravel and a recirculating nutrient solution. The rate of circulation is kept high in order to minimize concentration gradients especially at the root and macronutrients are added if necessary bi-weekly on the basis of frequent chemical analysis of the solution. The following treatments were compared:

1. macronutrients high; micronutrients low
2. macronutrients high; micronutrients high
3. macronutrients low; micronutrients low
4. macronutrients low; micronutrients high

Table 88 shows the total increase in length of branches and the chemical composition of leaves, 12 weeks after planting.

Despite the late time of planting the levels of N and K at the end of July

were high to very high and the shoot growth was relatively strong. Of course the very good availability of water and nutrients will have caused these effects but the temperature of the root environment has also been higher because of the pumps recirculating the solution. This may also have contributed to the strong reaction. The combination of low macronutrients and high micronutrients had a negative affect on growth and % K in the leaf. This experiment will be terminated at the end of the winter by counting the number of flower buds and by chemical analysis of the different plant parts.

Table 88. The effects of a continuous supply of water and nutrients in an artificial gravel substrate on shoot growth and the concentration of N and K in the short shoot leaf on 31 July, 12 weeks after the planting of cooled plants.

Treatment Hfd.elem.-Sp.elem.	Shoot growth in m/tree	Short shoot leaf	
		% N	% K
Low - Low	5.4	2.39	1.92
Low - High	3.9	2.46	1.85
High - Low	7.1	3.10	2.21
High - High	7.4	3.13	2.24

CONTROL OF QUALITY OF PIT AND STONE FRUIT BY WATER AND NUTRIENT SUPPLY

M.P. van der Maas and P.J. Bolding

Improvement of the Ca-uptake

At 3 locations (Wilhelminadorp, Numansdorp and Zeewolde) experiments have been started in which the supply of Ca is varied through fertigation in order to influence the Ca concentration in the fruit. Apart from a comparison between calcium nitrate and 19-6-6 (N mainly as ammonia) the 2 main treatments were application of extra Ca and application of a weak acid (acetic acid). On soils rich in calcium carbonate acid may increase the availability of free Ca considerably.

The data in Table 89 show no clear effect from any treatment on the concentration in the fruit. These experiments will be continued in 1993.

Table 89. Mg Ca per 100 gram fruit weight (fresh) and the K/Ca ratio in Jonagold and Cox's Orange Pippin in Numansdorp with calcium nitrate as standard fertigation.

Treatment	Jonagold		Cox's Orange Pippin	
	Mg Ca	K/Ca	Mg Ca	K/Ca
Standard fert.	4.7	25.8	4.6	32.9
St. fert. + Ca	5.2	24.9	4.9	30.7
St. fert. + Ac.Ac	5.2	25.3	4.5	33.9
19-6-6	4.8	25.5	4.5	33.1

Transpiration measurements on apple trees: testing and improving the Heat-Balance method - F. Weibel (guest worker)

Introduction

Nowadays many fruit growers have (at their disposal) equipment for the controlled dosage of nutrient solution ("fertigation"). The optimal use of this apparatus for the controlled application of water according to the daily use requirement is as yet impossible since good systems for the measurement or calculation of daily water use are lacking. To solve this problem a water-use model is being developed based on meteorological parameters (especially light interception). With a good model the fertigation units could be controlled by daily weather data. For testing and improving such a model an accurate method is needed for measuring real water use by trees in the orchards.

The ideal equipment for transpiration measurements should 1) work without disturbing the normal functioning of the tree in its natural environment, 2) measure continuously and automatically and 3) also work reliably during extended time periods.

To meet all these requirements, the so-called Stem-Heat-Balance method is the most promising. The principle of this method is that a short section of the stem (ca. $1.5 \times$ stem diameter) is heated by a well isolated heating ribbon.

By accurately measuring temperatures at different distances from the heated place all components of heat loss (Watts) can be calculated. One of these components is the convective heat loss by the rising sap. Sap flow rate can be calculated from these data as grams per time period.

With young apple trees there are, however, two specific difficulties. The bark is very thin and has numerous, active lenticells on its surface. Consequently heat damage easily occurs and condensing water may disturb measurements. The second problem is that typical 'modern' apple trees have many overgrown wounds from former treatments in the nursery. Thus the stem is not straight cylindrical and is sensitive to manipulations on its surface. This makes it very difficult to install a "standard"-gauge in the correct way.

Performance

The first step of the project in 1992 was to test the suitability of a commercially available sapflow meter system ("Dynagage" by DYNAMAX, USA Houston, Texas) on potted apple trees in the glasshouse, and - if necessary - to develop and test technical and/or theoretical modifications. The accuracy tests were carried out on 1-to 4-year-old trees with 10 to 38 mm stem diameter. As a reference method the gravimetric weight loss of the measured trees was recorded automatically (every 15 min.) by a balance weighing up to 60 kg with a reading resolution of 1 gram.

In case a reliable system could be found, additional longer term measurements were planned on orchard trees for reliability tests and also for comparing these sapflow data with the transpiration rates calculated by a transpiration model.

Results

We found that with smaller trees, with stem diameters up to 23 mm, the measurements of the commercial sapflow meter were very good, having a deviation of less than 5 % within 24 hours and less than 10 % within 30 minutes compared to gravimetric weight loss. With increasing stem diameter (> 2.7 cm), however we found considerable time lags in situations where the

sapflow changed drastically e.g. at the beginning and the end of the light period. It could be shown that this error was due to the influence of stored energy (within the heated stem volume) which is not taken into account or measured in the stem heat balance of the commercial system. A further problem was the occurrence of overheating in periods of low sap flow. As a reaction to that the lenticells of the bark under the heater showed hyper-intensive growth which is not ideal for a close contact of the heater element with the stem. In some cases the bark turned dark brown with necrotic "burnings" of the phloem there.

On uneven stems an optimal contact of the heater (and the thermocouples) with the stem could not be achieved. This resulted in errors of sap flow rates of between 7 - 15 % during the light period. In field use, errors of this magnitude would be difficult to detect because no practical reference methods (e.g. a scale) exist.

For all these reasons we modified the stem-heat-balance system according to the ideas of Ishida et al. 1991 constructing an electronic unit to control continuously the power input to the stem. In order to provide complete contact of the instrument with the stem-surface we kept all elements of the gauge separate and attached them individually to the trunk.

The experiments on trees with a diameter between 2.7 and 3.1 cm showed that controlling the power input resulted in 3 improvements: 1) the bark tissue under the heater was no longer negatively affected, 2) the influence of stored energy was minimized; this meant that even in periods of drastic changes in sap-flow rates constant conditions for the heat-balance calculations were produced and a high accuracy in sap-flow measurements could be maintained, and 3) battery power was saved. Figure 13 shows the measurement of sapflow according to the improved method compared with the weighing method in a 3-year-old Elstar tree with a diameter of 2.5 cm.

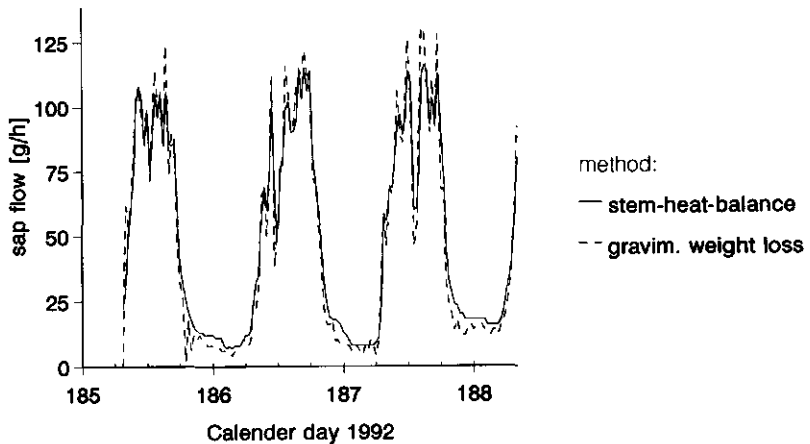


Figure 13. The course of water movement in the stem of a 3-year-old Elstar tree with a diameter of 2.5 cm according to the "heat-balance method" and according to the weighing method.

Experiments on a 9-year-old tree in an orchard (stemdiam. 95 mm) showed that the sap-flow profile in radial direction can be very inhomogenous and variable during the course of a sunny day because of the uneven illumination of the tree canopy and different parts of the crown have their own preferential xylem connections to the roots. It could be shown that for a

correct heat balance of a stem of that size a term for stored energy should be introduced (in spite of controlling the power input). The reason for this is that the stem volume which is not sap-conducting - but storing and releasing energy - is becoming relatively more important with increasing stem diameter. Thus for bigger trees the sensors have to be much more costly in construction and in handling, as well. In 1993 we pay further attention to these aspects.

IMPROVEMENT OF THE ADVISORY SYSTEM FOR FERTILIZATION OF STRAWBERRIES AND OTHER SMALL FRUIT CROPS IN THE OPEN

M.P. van der Maas and P.J. Bolding

A system for additional N fertilization

The aim of this project is to adapt the fertilization strategy for the growing of strawberries and raspberries in the open in order to meet future environmental demands with regard to nutrient loss to the subsoil.

Guided by frequently collected data on the concentration of mineral nitrogen (Nmin) in the soil, N should be supplied to the plants regularly in order to just meet the requirement of the plant.

On a field at the experimental garden at Breda, 2 treatments were compared during the season of which one had been supplied with 16 tons/ha of organic manure (from the "champignon" substrate) before the start of the growing season in addition to mineral fertilizer and one was supplied with mineral fertilizer only. Each week soil samples were taken during the period 21 April to 3 November from the layer 0 - 30 cm. Before the second half of May no differences could be detected, both fields showing levels of about 40 kg of N per ha. From mid-May to mid-June the field with organic manure had Nmin at a level of 80 kg per ha compared with 60 kg per ha in the control. From mid-June to the end of August Nmin decreased to 20 kg per ha in both fields and from the end of September less than 10 kg Nmin per ha could be detected.

These data show that especially in the period between mid-May and the end of August rather high Nmin levels may occur and the use of organic manure raises extra problems in the control of the Nmin level. Yet loss of Nmin to the subsoil during the summer is not very likely because in this period evapotranspiration exceeds precipitation. On the other hand high levels of Nmin may cause a decrease in fruit quality and also a high production of leaves which favours the development of moulds.

WATER AND NUTRIENT UPTAKE OF STRAWBERRIES AND RASPBERRIES

P.J. Bolding

The aim of this project was to quantify the uptake of water and nutrients by the crop during development.

The experiment of 1991 in which the uptake of nutrients was monitored by the harvesting method in raspberry (Malling Exploit) will be reported here. In this experiment we used 2 levels of fertilizer supply, with at each level

pots with 4 new shoots and pots without new shoots. Pot volume was 8 litres and 2 shoots were planted per pot. At 3 times (beginning, end and beginning of fruit harvest) plants were harvested completely to allow for an analysis of growth and a calculation of the uptake of nutrients.

Table 90. Fruit production and uptake of nutrients (Ca, K, N) per container from the start to the end of the experiment.

Object	Yield (g)	Uptake (g)		
		Ca	K	N
1. N 0 shoots*	1060	1,46	3,66	2,64
2. N 0 shoots	1095	1,69	4,19	3,61
1. N 4 shoots	762	2,43	4,23	3,05
2. N 4 shoots	868	2,71	6,06	5,12

* 8 weeks 19-6-20-4, with N at a rate of 5 gram N per season; dosage once in 3 days.

As an average for all treatments the Ca concentration of the leaf increased from 1.20 to 2.68 % and the Mg concentration from 0.47 to 0.73 % whereas the K concentration decreased from 2.27 to 1.97. N and P concentration remained constant at 2.82 % and 0.27 % respectively. Leaving the new shoots did not influence the concentration of Ca and K in the leaf but lowered the N concentration. The uptake of nutrients from the start of the experiment is shown in table 90.

The uptake of Ca was increased slightly and the uptake of K and N was increased very clearly by doubling the rate of fertilizer supply, especially when new shoots were not removed. Per kg of fruits respectively 1.40 and 1.65 gram of N was taken up at the low and the high rate of N supply when shoots were removed and 1.45 and 1.65 gram of N when shoots were not removed.

In 1992 growth and uptake experiments with raspberries were conducted with the varieties Spica and Glen Prosen. In these experiments single salts were used and unfertilized potting soil.

For both varieties the following treatments were applied:

- low N and low K (1N1K)
- high N and high K (2N2K)
- high N and low K to the end of flowering and then low N and high K (2n1K/1N2K)
- low N and high K to the end of flowering and then high N and low K (1N2K/2N1K).

Low N and low K mean 5 grams of N and of K for the whole season.

From the first 2 treatments a number of pots were harvested completely at the beginning and the end of the experiment to calculate the nutrient uptake. Nutrient analyses are not yet available

The experiment with Spica started by planting on 4 February. After that the pots were placed in the unheated tunnel. Watering started on 15 March and fertigation at the beginning of April. The experiment with the variety Glen Prosen was carried out in an identical way but with cooled plants starting on 1 July. Pots were fertigated from 15 July until the end. Per pot 2 shoots were

planted and 2 new shoots were allowed to develop.

Table 91 shows that, especially at the low N supply yield was lower than at the high N supply, especially in the variety Glen Prosen. In the variety Spica a slightly higher % of the fruits were of class 2. In this variety initial growth was not very good maybe because of the fact that the potting soil was not fertilized and at first only water was supplied before starting fertigation. However, later on the growth of this variety improved. Midharvest date was some days later at the higher N level than at the lower N level.

Table 91. Yield per container, estimated leaf colour and midharvest date for the varieties Spica (February to July) and Glen Prosen (July to October).

Treatment	Spica		Glen Prosen			
	Yield (g)		Leaf colour		Yield (g)	Midharvest date
	qual. I	qual. II	11 May	29 June		
1N 1K*	544	64	4.4	3.9	822	9 September
2N 2K	674	84	5.8	7.3	1032	12 September
2N1K/1K2N	654	60	5.3	6.6	915	13 September
1N2K/2N1K	651	51	4.6	6.2	870	8 September

* composed of single salts on the basis of 5 gr N and 5 gr K for the season.

These experiments show that an increased level of nutrient supply has a positive effect on yield.

 C R O P P R O T E C T I O N D E P A R T M E N T

SPRAYING TECHNIQUE

TESTING AND DEVELOPMENT OF APPLICATION TECHNIQUES IN CROP PROTECTION

B. Heijne

Comparison of tunnel-spraying devices

Design and results in 1991

In 1991 at Numansdorp, an experiment was carried out, in which the activity of a tunnel-spraying device was compared with a cross flow sprayer. The action of sprayers was measured against apple scab (*Venturia inaequalis*) and mildew (*Podosphaera leucotricha*).

Spraying devices were a Noric-Joco experimental tunnel sprayer EX-2 and a van den Munckhof cross flow sprayer. Sprayings were made with 75 %, 50 % and 25 % of the dose advised by the Extension Service (DLV) and an untreated control. The experiment was set up according to a randomized block design with 5 replicates. Cultivars were Jonagold and Vista Bella on M.9-rootstock in the fourth year of growing and planted in a single row (3 x 1.25 m). At intervals of 7 to 10 days applications were made with captan and if necessary Pallicap (captan 55.3 % + nitrothal-isopropyl 16.7 %). Speed of driving was 4.2 km/hour for the tunnel sprayer and 6.8 km/hour for the cross flow sprayer. The tunnel sprayer had 4 Noric rotor atomizers which were adjusted to deliver 75 l/ha; the cross flow sprayer had 10 Albuz (violet) hollow cone nozzles and delivered 150 l/ha.

On untreated plots, the scab infection on leaves of short shoots and long shoots was respectively 1.1 % and 4.3 % and less than 0.3 % in all treatments. The percentage of Jonagold fruits with scab was 44.4 % in the untreated. For the tunnel sprayer, this percentage was 3 % and 2.8 % and for the cross flow sprayer 1.8 % and 3.3 % respectively for the dosage of 75 % and 50 %. Those treatments differed significantly from the 25 % dosage, where 6.5 % and 5.3 % of the fruits were infected with scab for the tunnel and the cross flow sprayer respectively.

The untreated plots had 34.2 % of the long shoots with one or more leaves infected by mildew. This percentage was lower than 3.6 % for all treatments. There were no significant differences between the 2 spraying devices with respect to scab and mildew control. Scab control on fruits was insufficient at the lower dosages.

Part of the spray liquid, which missed the tree, was collected on the screens and re-used with the tunnel sprayer. This was 45 % of the sprayed liquid in early spring when trees were still bare. The percentage decreased to 15 % as more foliage developed. The average percentage spray liquid recycled, was about 30 % throughout the whole season.

Design and results in 1992

A similar experiment was carried out in 1992. The action against scab and

mildew was tested with 4 sprayers: 2 tunnel sprayers from the companies Douven and van den Munckhof, a cross flow sprayer with reflection screens from Holder-Platz and a normal cross flow sprayer from van den Munckhof. Sprayings were made with 75 % and 25 % of the dose advised by the Extension Service (DLV) and an untreated control. The experiment was set up according to a randomized block design with 5 replicates. Cultivars were Elstar and Cox's Orange Pippin on M.9-rootstock in the fifth year of growing and planted in a single row (3 x 1.25 m). From 10 April at intervals of about 10 days, applications were made with Topaz-S and from 15 July with captan plus Pallitop. Speed of driving was about 6 km/hour for all spraying devices and quantities were 200 l/ha for the cross flow sprayer, 80 l/ha for the Douven tunnel sprayer, 150 l/ha for the Munckhof tunnel sprayer and 175 l/ha for the Holder reflection screen cross flow sprayer. All sprayers had Albuz (violet) hollow cone nozzles and were operated at 7 bar, except the Douven tunnel sprayer which had 4 Noric rotor atomizers operating at 2.8 bar.

People from the Institute of Agricultural Engineering (IMAG-DLO) measured deposition and drift of spray droplets. These results are reported elsewhere.

The dead volume is the volume of tubes still filled with liquid after the tank is emptied. The dead volume of the Douven tunnel sprayer was measured by the Staring Centre (SC-DLO) with the aid of a dye. The dead volume of the other sprayers was estimated. Tanks were filled with one concentration spray liquid. The spray liquid was diluted by clean water from the dead volume. This dilution was different for each spraying device, because the dead volumes were different and the quantity of spray liquid prepared for each device was different. Thus, concentration of spray liquid was different for the different devices. The actual concentrations are mentioned in Table 92.

Table 92. The percentage of short and long shoots infected by scab at the actual dose of Topaz-S for different spraying devices.

Topaz-S g/ha	Sprayer type	Elstar		Cox's O.P.
		short shoot	long shoot	short shoot
untreated		2.8	4.9	1.6
475	crossflow spayer	1.3	2.0	1.0
475	Munckhof tunnel sprayer	1.4	2.1	1.3
415	Douven tunnel sprayer	2.0	3.6	1.2
1425	crossflow sprayer	0.4	1.2	0.4
1365	Munckhof tunnel sprayer	0.8	0.8	0.3
1245	Douven tunnel sprayer	1.3	3.6	1.2

Statistical analyses show that results from untreated plots do not differ from results using the Douven tunnel sprayer and that results from the cross flow sprayer do not differ from those from the Munckhof sprayer. These results are strengthened by counts of scab on fruits as shown in Table 93.

All treatments are better than untreated with Cox's Orange Pippin, but there is no difference between the treatments. For Elstar, the Douven tunnel sprayer was less effective than the cross flow sprayer. The Munckhof tunnel sprayer does not differ from the cross flow sprayer. The low dosage was significantly less effective than the higher dosage.

Results of scab are confirmed by the infection of mildew on long shoots (Table 94). The Douven tunnel sprayer does not differ from the untreated, and the Munckhof tunnel sprayer was as good as the cross flow sprayer.

Table 93. The percentage of fruits with scab at the actual dose of Topaz-S for the different spraying devices.

Topaz-S g/ha	Sprayer type	Elstar fruit	Cox's O.P. fruit
untreated		32.6	3.7
475	crossflow sprayer	5.1	1.2
455	Munckhof tunnel sprayer	6.0	0.5
415	Douven tunnel sprayer	19.9	1.5
1425	crossflow sprayer	0.5	0.4
1365	Munckhof tunnel sprayer	1.4	0.5
1245	Douven tunnel sprayer	3.4	1.1

Table 94. The percentage of long shoots infected by mildew at the actual dosage of Topaz-S for the different spraying devices. The whole shoot counts as infected if a single leaf has a single spot of mildew.

Topaz-S g/ha	Sprayer type	Elstar long shoots	Cox's O.P. long shoots
untreated		61.0	38.4
475	crossflow sprayer	31.0	14.9
455	Munckhof tunnel sprayer	32.6	13.0
415	Douven tunnel sprayer	50.6	19.8
1425	crossflow sprayer	11.0	6.8
1365	Munckhof tunnel sprayer	12.0	7.6
1245	Douven tunnel sprayer	19.8	15.5

Part of the spray liquid, which missed the tree, is collected by screens of the tunnel sprayers and the reflection cross flow sprayer. This spray liquid is pumped back into the tank and re-used; this is called recycling of spray liquid. The average percentage of spray liquid is measured (Table 95).

Table 95. The average percentage recycled spray liquid for the different spraying devices.

Sprayer type	% recycling
Munckhof tunnel sprayer	14.5
Douven tunnel sprayer	43.8
Holder reflectionscreen sprayer	11.0

Discussion

The Noric-Joco EX-2 tunnel sprayer used in 1991 has been further developed by the company Douven. The Douven tunnel sprayer (1992) has long and thick tubes and therefore a large dead volume (at least 6 l). The tanks of all sprayers were emptied and rinsed with clean water before and after each application. Therefore the spray liquid was diluted by the clean water which was in the dead volume. The calculated dilution is shown in Table 96. Note,

that the dead volume of the Douven tunnel sprayer is measured and that of the other sprayers estimated.

Table 96. The percentage dilution of the spray liquid for the different spraying devices.

Sprayer type	% thinning
Munckhof tunnel sprayer	9
Douven tunnel sprayer	17
crossflow sprayer	5

The Douven tunnel sprayer had a large pump and while sucking spray liquid, collected for re-use, back into the tank a lot of air was mixed in the spray liquid. The consequence was foaming. Although the concentration of active ingredient was the same in the foam as in the spray liquid, one might apply less than expected, because air is applied to the trees rather than spray liquid. On a number of occasions blockages occurred at the small orifice in the plate which controls the spray volume of the Douven tunnel sprayer. At those dates less spray liquid was applied than expected; how much is unknown. Part of the spray liquid that was released from the atomizers was not directed to the tree, but was directly caught by the screen on the same side as the atomizer and recycled. It appeared to be about 12 % of what was released by the atomizer. This quantity is included in spray liquid recycled. If one subtracts this 12 % from the measured recycling of 43.8 %, there remains 31.8 %, the real percentage recycled, which is in accordance with what was measured in 1991 and in other countries.

The factors just mentioned have reduced the dosage per ha considerably. In Figure 14, this reduction is reckoned with. The percentage of fruits with scab is plotted against the calculated dosage of Topaz-S as applied per ha per spraying and independent of the type of sprayer. It appears that with increasing dosage the percentage of fruits infected by scab decreases, exactly as expected. The Douven tunnel sprayer compares well.

INFECTION WITH SCAB Elstar (1992)

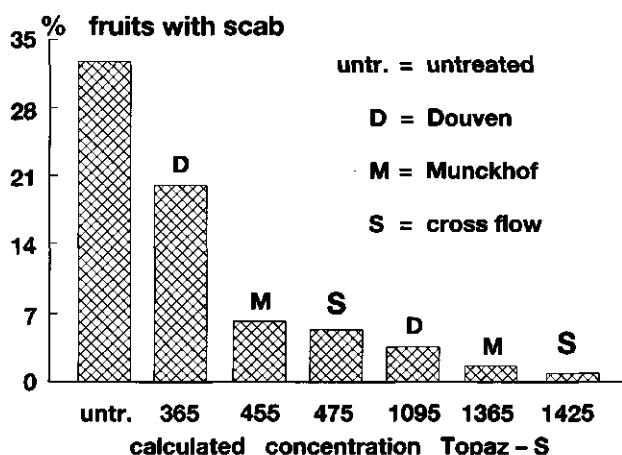


Figure 14. The percentage of Elstar fruits with scab infection plotted against the calculated quantity of Topaz-S in g per ha per application with different sprayers; DW = cross flow sprayer, D = Douven tunnel sprayer, M = Munckhof tunnel sprayer and onb = untreated.

Conclusion

Both tunnel sprayers and the cross flow sprayer with reflection screens should be improved to be useful for fruit growers. Due to complications during the experiment in 1992, it is difficult to make a judgement about the action of the tunnel sprayers and the cross flow sprayer with reflection screens.

Reduction of the dosage resulted in too much scab on the fruits in 1992.

PHYTOPATHOLOGY AND WEED CONTROL

BIOLOGY AND CONTROL OF SECONDARY OR SPORADIC DISEASES IN FRUIT CROPS

H.A.Th. van der Scheer

Black spot in strawberry

The causal fungus of black spot in strawberry is *Colletotrichum acutatum*. The disease is mainly a problem in the strawberry runner production fields. In continuation of a trial carried out in 1990 in the experimental garden at Breda the effect of prochloraz against *Colletotrichum acutatum* on runner plants was tested. The trial field was infested with the fungus sporulating on apple parts, at the time of "closing" of the surface by the young plants. Then the first spray was applied. Two further sprays were applied, each at an interval of 14 days. For detailed counting all plants on one quarter of each plot were dug and assessed for disease incidence on 29 September and for number of produced runner plants on 10 December. Prochloraz was effective at a dosage of 0.24 g/l. Any improvement by raising the dosage to 0.9 g/l was statistically not significant. The production of runner plants was not significantly raised by the prochloraz treatments.

Roesleria pallida on pear

In 1992, the fructifications of *Roesleria pallida* were seen on dead roots of young pear trees in 9 different orchards, most of them situated in the province of Zeeland. In almost all cases 1-or 2-year-old trees of the cultivar Conference on quince MC were involved. It has been 11 years since the disease was recorded for the first time from young trees of the same cultivar rootstock combination in an orchard in Zeeland. Diseased trees were on the decline, showing at first a slight yellowing of the leaves. Then the leaves fold, shrivel and discolour due to lack of water, and drop early. The trees become defoliated and die. In this stage small, greyish fructifications of the pathogen can be found wholesale on the surface of the roots. They produce ascospores which spread by water in the ground. Roots with fructifications are thus infection sources. The pathogen grows best at somewhat higher temperatures and then attacks weakened young trees. Presumably the less good compatibility of Conference with quince MC makes the combination more susceptible for the pathogen.

Growth of the pathogen in vitro was inhibited by captan and thiofanate methyl. After 14 days the diameter of *Roesleria pallida* cultures on PDA alone or on PDA amended with 0.12 g/l a.i. captan or 0.07 g/l a.i. thiofanate methyl

was respectively 6.5, 0.5 and 0 cm.

TESTING OF INSECTICIDES, FUNGICIDES AND BACTERICIDES IN FRUIT GROWING

H.A.Th. van der Scheer, J. Woets, M.M. Giezen, W. Remijnse and H.J. Wondergem

Fungicides for control of powdery mildew on strawberry

In the experimental garden at Geldermalsen some fungicides with known activity for powdery mildews, were tested for effectivity against *Sphaerotheca aphani*, the causal fungus of powdery mildew on strawberry. Elsanta cold-stored waitingbed plants, planted on 16 July in peat bags put on a rack, were used as test plants. The first spray was applied on 14 August. Three further sprays were applied, each with an interval of 7 days. Disease incidence of leaves and fruit was assessed in the third week of September. The best disease control was achieved with 0.75 g/l fenpropimorph, 0.075 g/l triadimenol, and 0.15 g/l pyrazophos. Second best were 0.05 g/l pyrifenoxy, 0.45 g/l prochloraz, and 0.08 g/l fenarimol. The third group in ranking comprised of 0.025 g/l triadimefon, and 0.25 g/l nitrothal-isopropyl.

Fungicides for control of crown rot in strawberry

In the experimental garden at Breda the fungicide SBO 8801 was tested for control of crown rot caused by *Phytophthora cactorum*. Two field trials were carried out on Elsanta and Avanta as test plants. The pathogen is a wound parasite and thus often invades the strawberry plants directly after planting. Therefore the fungicide was sprayed directly after planting, in June and July, over the plant rows. One month later the plants were assessed for disease symptoms. Unfortunately disease incidence was low and confined mainly to Avanta plants in the first trial which were kept untreated or were treated with 6 kg/ha a.i. fosetyl-aluminium. In that trial hardly any diseased plant was observed, if they were treated with 0.375 kg/ha a.i. metalaxyl or sprayed with 1.5 kg/ha f.p. SBO 8801.

Fungicides for control of apple scab

In the experimental gardens at Geldermalsen and Numansdorp trials were carried out to test the effectivity of some fungicides for control of scab on apple. Both SchAA 4269 and BAS 490.04 F showed good preventive and curative activity. The fungicide SchAA 4267 did equally well at Geldermalsen, but gave no adequate control in particular of leaf attack when applied in a preventive spray scheme at Numansdorp. At Numansdorp the curative action of this fungicide was not tested. In general the fungicides protected leaves more than fruit for scab attack. Hardly any powdery mildew was observed in both trial fields. Therefore it was not possible to test the fungicides for activity on this disease.

Fungicide resistance of scab

The germination of conidia of *Venturia inaequalis* was tested in drops of

water containing different bitertanol (Baycor) or penconazole (Topaz 100 EC) concentrations, ranging from 0 to 20 mg/l active ingredient. The conidia were collected from 6 orchards with a scab problem in 1992. The germination of conidia from unsprayed trees was also checked. Part of the conidia from all sources did not germinate. The germinating conidia produced malformed germ tubes in water drops containing a fungicide. The rate of malformation and the length of the germ tubes differed per conidia source. Germinated conidia from unsprayed trees produced the most malformed and shortest germ tubes in drops with a fungicide. That indicates a reduced sensitivity for EBI-fungicides in the conidia from the other sources. The length of the malformed germ tubes of the conidia in the drops containing bitertanol was inversely correlated with the concentration of bitertanol in these drops. That effect was less clear for germ tubes produced in water drops containing the fungicide penconazole. After a few days the malformed germ tubes disintegrated and their walls dissolved.

Pheromone disruption of leaf rollers and codling moth

There are good chemicals available to control leaf rollers and codling moth in apple and pear, but less persistent compounds would be preferable.

During 1992 the pheromone dispensers RAK 3+4 of Bayer were tested again. They contain 250 mg E,E-8,10 dodecadienol (codlemone) and 250 mg 2-11-tetra decenyl acetate. The last one is a component of the sex pheromones of the summer fruit tortrix *Adoxophyes orana*, the fruit tree tortrix *Archips polana*, *Pandemis heparana* and the rose tortrix *Archips rosana*.

In each of 4 orchards (= replications) there were 3 treatments: untreated (0.5 ha), standard (1 ha; if necessary phenoxycarb and diflubenzuron) and disruption (1 ha). This year 300 dispensers were used per ha. Again the differences in fruit damage between the 3 treatments were not significant. The numbers of males caught in the disruption plots were strongly decreased compared with the other treatments. Nevertheless so many males were caught that it is indicated that 300 dispensers per ha is low for good results.

Black currant gall mite

There are no registered chemicals for control of the black currant gall mite *Cecidophyopsis ribis*. The increasing acreage initiated more damage by the mite and the mite-born reversion disease.

In 1992 1 new chemical and 3 well known chemicals tested in other fruit crops were tested. In March they were sprayed twice on infested Ben-Nevis. At the end of September bud-galls were counted on labelled shoots, soil shoots and all newly-formed shoots. Comparison of the results of the 3 shoot-groups made obvious that labelled shoots gave less reliable information than the other shoots.

It is possible to use only 2 of the tested chemicals. They showed 45 % and 37 % control. They will possibly give better results if more sprayings are carried out and if sprayings are better timed.

Apple rust mite correction

The standard acaricide used against apple rust mite *Aculus schlechtendali* (Torque-L) is toxic for water organisms. Two new acaricides (A and B) and 1 fungicide with side-effect on mites were investigated for efficacy against apple rust mite *Aculus schlechtendali* and for safety for predatory mite

Typhlodromus pyri.

At the end of July the pesticides were sprayed in 4 replicates on Jonagold. Four days after treatment mites were counted on leaves (Table 96).

Table 96. Average number of apple rust mite and predatory mite on 20 leaves.

Pesticide	Apple rust mite	Predatory mite
Water	17 a	13 a
Acaricide B	11 b	16 a
Acaricide A	10 b	8 ab
Torque-L	4 c	7 ab
Fungicide	2 c	4 b

A pesticide as good as Torque-L has not been found. The fungicide is not significantly different from Torque-L but it is the only tested pesticide that is significantly more harmful to predatory mites than water. A higher dosage of acaricide A or B (which are safe for predatory mites) may give equal apple rust mite control. On the other hand in a biological system, it is not desired to get total control of pest, because it is also prey.

Maybe lower dosage of fungicide will still be efficient against apple rust mite and be safe for the predatory mites.

SUPERVISED CONTROL OF SCAB

H.A.Th. van der Scheer

Infection sources

At Wilhelminadorp the first ripe ascospores of *Venturia inaequalis* were detected on 9 March. Belle de Boskoop already possessed green parts for some days by 9 March. Then the development of the pseudothecia of the pathogen was followed. On each of 4 times, 20 pseudothecia were crushed and the number of ripe and unripe asci assessed. On average very few asci per pseudothecium were observed: only 35 at the middle of the ascospore flight period. That is half the average number of asci per pseudothecium observed in preceding years. In March, Ir. J. Bloksma from the Louis Bolk Institute investigated at Wilhelminadorp the presence of conidia on twigs of organically grown apple trees from 8 different commercial orchards. Per orchard 20 buds were taken from the twigs and each twisted in a drop of water. The presence of conidia was confirmed under the microscope for half of the orchards, 3 of them planted with Elstar and 1 with Golden Delicious.

Pre-blossom supervised scab control

The study to investigate the establishment of an action threshold for control of scab was carried out in a trial field in each of 10 orchards. The procedure was the same as the one described in the Annual Report for 1990 on page 84. In the autumn of 1991 some scab was observed in 6 of the 10 orchards. As in both preceding years on average 40 % of the soil surface in the trial

fields was covered with leaf litter at the time of bud burst in the spring. From both parameters, disease incidence in the autumn and cover of soil surface with leaf litter in the spring, the Potential Ascospore Dose (PAD) of each trial field was determined. The PAD's for the trial field orchards with scab in the autumn ranged from 9 to 82. In 1992, in general more apple scab occurred than in preceding years. In 9 of the 10 trial fields scab was observed on fruit in plots under a regime of a full spray program for that particular orchard. Nevertheless, delay of the first spray could be achieved on plots in most of the trial fields without causing extra damage. In so doing, a delay of 45 days from the moment of the first ripe ascospores being present, could be achieved in 6 trial fields. In 3 other trial fields a maximum delay of 31 days could be achieved without causing extra damage. On the other hand a delay of 29 days before the routine spray program by the grower in one of the trial fields resulted in far too much damage (7.6 % scabbed fruits). In the plots of the trial field concerned where the first spray was delayed even longer, the results were a disaster. Afterwards a strong infection source was detected near this trial field. As long as it is impossible to record how many spores do fly into an orchard, delay of the first spray is a risky practice. It is only right to do so in isolated orchards.

BIOLOGICAL CONTROL OF DISEASES IN FRUIT CROPS

H.A.Th. van der Scheer

Canker on apple

In 1992 also, micro-organisms were isolated from old cankers in neglected orchards and then selected for antagonistic properties towards *Nectria galligena*. This year the antagonistic activity of the micro-organisms was tested at first in vitro on potato-dextrose-agar (PDA). Those with a positive reaction against the growth of *Nectria galligena* were tested again, but this time on wounded apple twigs as described in the Annual Report for 1991 on page 99. As a result 4 fungal isolates could be added to those already selected for antagonistic properties in 1991.

In 1991 6 isolates were selected for antagonistic properties. These were tested for survival on branches of apple trees. In January branches of Cox's Orange Pippin were wounded with a scalpel and then smeared with a suspension of an antagonist. However, re-isolation after 1 to 3 weeks of the antagonists from the surface of the branches or from the wound tissue failed.

In organic fruit growing the wound protectants Dendrosan and Tervanol are used, because they do not contain a fungicide. These protectants are not so effective when applied to the surface of cankers that are not well scarified. Therefore both were mixed with each of the 6 antagonists isolated in 1991, in the hope of improving their effectiveness. However the antagonists survived for only a short time in the mixtures. After 4 days they no longer grew out of the mixtures when these were smeared on PDA.

Directly after their preparation the mixtures were painted on to scarified cankers in branches of Golden Delicious apple trees. Scarification was not done so well in order to create a good opportunity for evaluation of the disinfecting action of the mixtures. The treatments were carried out in April. In August, when the result was evaluated, not much regrowth of *Nectria*

galligena was observed. The differences in number of cankers with regrowth between the treatments were statistically not significant.

METHODS OF WEED CONTROL IN FRUIT GROWING

H.J. van Hartingsveldt

Weed control equipment

In 1992 an experiment was begun at the Experimental Station Zeewolde to study the weed control efficacy of several tools that are potentially economical with herbicides: 2 different wick applicators and a covered spraying tool.

The covered tool sprays small droplets because a higher pressure is used, which may result in a better distribution of the herbicide.

Table 97 shows the treatments which were tested in this experiment. Herbicide "A" is a biologically degradable herbicide, which is not legally approved. Treatments 1 and 2 were carried out with the current weed spraying device. Wick applicator X distributes the herbicide solution by hitting the weeds with a kind of cloth, wick applicator Y uses a brush. The trial was begun in June, when all the equipment was available. All treatments were carried out once at that time. On 6 August and 24 November, the percentages of soil covered by weeds were estimated. The averages are presented in Table 97.

Table 97. Percentage soil cover by weeds, 6 August and 24 November 1992.

Treatments	% soil cover by weeds	
	6 August	24 November
1. 2 l simazine + 2 kg diuron + 4 l Roundup	1.7 a*	5.7 a
2. 4 l Roundup	5.0 a	50.8 bc
3. wick applicator X, 20 % Roundup solution	12.5 b	45.0 bc
4. wick applicator X, 10 % Roundup solution	14.2 b	55.8 c
5. wick applicator X, 10 % A herbicide "A"	19.2 c	57.5 c
6. wick applicator Y, 20 % Roundup solution	12.5 b	36.7 b
7. wick applicator Y, 10 % Roundup solution	10.8 b	33.3 b
8. covered sprayer, 80 % of treatment 1	4.2 a	7.2 a
9. covered sprayer, 50 % of treatment 1	4.2 a	7.5 a
L.S.D.(0.05)	4.1	18.2

* Values followed by a common letter are not significantly different (0.05).

Both with 80 % and 50 % of treatment 1, which is the most usually recommended combination of herbicides, a similar result was obtained with the covered sprayer to that with the current sprayer on both dates. It is thought that a better distribution of the herbicides occurred in treatments 8 and 9, resulting in a similar efficacy. This is not yet certain, however, because the comparison was not completed in this trial.

Despite the lower dosages in treatments 8 and 9, the weed control on

24 November was equivalent to treatment 1. Both wick applicators also produced a less effective weed control.

Both Roundup concentrations, applied by the wick applicators, gave a similar result. Herbicide "A" with the wick applicator was less effective than Roundup.

These results are provisional, because the trial was not complete and did not start at the beginning of the growing season. It will be extended and continued in 1993.

Low dosage application of herbicides

In 1992 an experiment was begun at the Experimental Station Geldermalsen to test the effectiveness of low dosage application, of herbicides. In this weed control method, the spraying is carried out on small weeds, because they are more sensitive. This has to be repeated several times: each 8 - 10 days, when new weeds have germinated. Dosages used are 10 - 30 % of normal. Often a kind of additive is used. When the total number of applications is limited, this may be a way to reduce the amount of herbicides used.

For this trial some herbicides that are approved in fruit growing were selected, plus a herbicide "B" that gave good results in trials in arable farming. Exell (0.5 l) was used as an additive in treatments 2 - 9. Application dates in 1992 were 22 April, 9 and 26 May, 12 June and 20 July.

Treatments in 1992 (per ha tree strip):

1. 2.0 kg diuron 80 % + 2.0 l simazine 500 g/l
2. 0.5 l glyphosate 360 g/l*
3. 1.0 l glyphosate 360 g/l**
4. 0.3 kg diuron 80 %, alternated with 0.5 l glyphosate 360 g/l*
5. 0.6 kg diuron 80 %, alternated with 1.0 l glyphosate 360 g/l**
6. 0.3 kg B*
7. 0.6 kg B**
8. 0.5 l gluphosinate-ammonium 200 g/l*
9. 1.0 l gluphosinate-ammonium 200 g/l**

* 10 % of the advised dosage.

** 20 % of the advised dosage.

Table 98 gives the weed cover resulting from the different treatments on 23 June.

Table 98. Percentage soil cover by weeds on 23 June 1992.

Herbicides	% soil cover by weeds	Species most commonly found
2 diuron + 2 simazine	3.4	<i>Poa annua</i>
0.5 glyphosate	7.8	<i>Poa annua</i> , <i>Senecio vulgaris</i>
1.0 glyphosate	2.6	<i>Poa annua</i>
0.3 diuron/ 0.5 glyphosate	7.2	<i>Senecio vulgaris</i> , <i>Poa annua</i>
0.6 diuron/ 1.0 glyphosate	6.0	<i>Senecio vulgaris</i> , <i>Veronica</i> spp.
0.3 B	11.4	<i>Poa annua</i> , <i>Senecio vulgaris</i>
0.6 B	15.2	<i>Poa annua</i> , <i>Senecio vulgaris</i>
0.5 gluphosinate-ammonium	11.8	<i>Poa annua</i>
1.0 gluphosinate-ammonium	25.0	<i>Poa annua</i>

After 4 applications, especially treatments with "B" and with gluphosinate-ammonium resulted in a relatively high weed cover. The treatments with glyphosate and with diuron/glyphosate resulted in a similar weed cover to treatment 1. *Poa annua* and *Senecio vulgaris* in particular were not adequately controlled.

Probably the low dosages were less effective because the gap between the 2 applications was too large. Therefore the sensitivity of the weeds had decreased. The trial will be repeated in 1993 with shorter intervals between the 2 applications.

Cover materials for the tree strip

All biologically degradable materials in the experiment that started in 1991 (see Annual Report 1991) decomposed too rapidly: the paper materials Mulchpaper, Variomulch and Ecopac; flax fibre and jute fibre, see Table 99. The decomposition of the papers was much more rapid than that of jute. BioStoll was too vulnerable. So the best cover material for weed suppression on the tree strip remains the black woven polypropylene (Horssol).

Table 99. Weed suppression by cover materials.

Material	Period with adequate weed suppression
1. Horssol	years*
2. Mulchpaper	4 - 6 weeks
3. Variomulch	4 - 6 weeks
4. Ecopac	4 - 6 weeks
5. jute fibre	10 - 12 months
6. flax fibre	3 - 4 months
7. BioStoll	6 - 8 weeks

* weeds may grow onto it from the edges.

COMPETITION BETWEEN CROP AND COVER CROP OR WEEDS

H.J. van Hartingsveldt

Cover crop on the tree strip

1992 was the second year of a trial at the Experimental Station Numansdorp with several plant species as a cover crop on the tree strip of apple trees, cultivar Cox's Orange Pippin. Weed suppression by the cover crop and growth and production of the trees were studied in this trial. In 1992 clear differences were observed, see Table 100.

Festuca rubra, *Agrostis capillaris* and *Trifolium repens* suppressed weed growth very well. These species established a good ground cover. *Poa pratensis* and *Festuca ovina* did it less well. The colour of the leaves was worse and the yield was lower at the 4 grass species treatments than at the white clover and the bare soil treatments. The latter 2 treatments did not result in a significantly different yield.

Table 100. Weed suppression, leaf colour, yield and number of fruits of Cox's Orange Pippin with different cover crops.

Cover crop	Weed suppression	Leaf* colour	Yield** (kg/tree)	Fruit** number/tree	Fruit weight (g)
<i>Poa pratensis</i>	moderate	5.9 b	17.3 bc	146 b	119
none (bare soil)	-	6.7 a	20.3 a	162 a	125
<i>Festuca rubra</i>	good	5.8 b	15.6 c	131 c	119
<i>Agrostis capillaris</i>	good	5.8 b	15.8 c	127 c	125
<i>Trifolium repens</i>	good	6.8 a	19.4 ab	150 b	130
<i>Festuca ovina tenuifolia</i>	bad	5.7 b	15.5 c	126 c	124

* assessment between 1 (yellow) and 8 (dark green), 13 August 1992.

** 10 September 1992.

Values followed by a common letter are not significantly different (0.05).

Tree strip width and fertigation of apple

Can increased competition, caused by a smaller tree strip and a wider grass path, be compensated for by more nitrogen fertigation? This is the question that has been studied in a trial at the Experimental Station Horst since 1989. Table 101 shows the results of this trial.

Table 101. Yield, fruit weight and colour mark of Jonagold and Cox's Orange Pippin with different tree strip widths and levels of nitrogen fertigation in 1992 and over the period 1990-1992.

Tree strip width (cm)	Ferti-gation (g N/tree)	Yield (kg/tree)				Average fruit weight (g)				Colour mark
		Jonagold		Cox's O.P.		Jonagold		Cox's O.P.		Jonagold
		'92	'90-'92	'92	'90-'92	'92	'90-'92	'92	'90-'92	'92
150	15	38.4	66.2	20.1	30.9	269	271	135	141	525
100	15	36.7	61.9	18.0	26.1	261	259	126	131	502
100	30	36.4	64.8	18.5	33.4	247	251	137	141	497
100	45	38.7	72.6	18.7	28.9	266	267	139	137	474
50	15	33.9	60.0	17.0	27.9	242	260	151	144	539
50	30	32.1	58.8	19.8	32.9	254	253	123	136	525
50	45	38.1	66.8	19.8	33.8	253	264	136	145	474

The production with a 100 cm and a 50 cm wide tree strip was at the same level as with 150 cm width, provided extra fertigation was given. For Jonagold, contrary to Cox's Orange Pippin, 30 g N does not seem to be sufficient at both widths, both in the yield of 1992 and of 1990 - 1992.

The average fruit weight of Jonagold decreased slightly with a decreasing width. For Cox's Orange Pippin this was not the case.

A higher N fertigation resulted in a lower colour mark for Jonagold. The colouring of Cox's Orange Pippin was not evaluated.

So generally, with a decreasing tree strip width, higher nitrogen fertigation kept the production at the same level, but the colouring was influenced negatively.

Tree strip width and rootstock of apple

In the winter of 1991/'92 a trial was planted in order to study whether a stronger rootstock is able to tolerate a narrower tree strip better. A more competitive rootstock could keep the growth and production at the same level. A reduction in the use of herbicides was the aim.

Different tree strip widths, rootstocks and planting distances were studied.

The tree strip widths were 0 cm, 35 cm, 75 cm, 150 cm, 150 cm (from 1994 35 cm) and 150 cm (from 1995 35 cm). Rootstocks were M.9, M.26, MM.106 with interstem M.9, and MM.106. Planting distances were 100 cm, 125 cm and 150 cm. The total number of treatments was $6 \times 4 \times 3 = 72$.

The cultivar was Queen Cox and the pollinizer (also used as buffer) was Alkmene Cevaal. The first results will follow in 1993.

Quantification of weed effects

One of the ways to reduce the amount of herbicides used in fruit growing is to limit their use to those situations when weeds are harmful to the trees. Therefore the effects of weeds on trees have to be quantified. In this project 2 approaches are followed:

- A. in which densities are weeds harmful?
- B. in which periods are weeds harmful?

A. Density of the weed vegetation

In 1992 a trial was set up in Ovezande (Zeeland) in which the influence on growth and production of apple trees by several densities of weeds were studied. For this trial 1 weed species was chosen: *Poa annua*. Three apple cultivars were studied: Alkmene, Golden Delicious and Jonagold, on rootstock M.9. With the herbicide gluphosinate-ammonium the different densities of the weeds were established. The trees were 7 years old at the start of the trial. Table 102 shows the yield of the trees in 1992.

Table 102. Yield of three apple cultivars in 1992 with several densities of *Poa annua*.

% ground cover by <i>Poa annua</i>	Alkmene	Golden Delicious	Jonagold	Average
8	18.3	30.4	26.8	25.2
52	19.2	28.9	27.5	25.2
78	19.3	28.3	26.5	24.7
92	18.5	28.9	24.0	23.8
L.S.D. (0.05)	3.36	3.36	3.36	1.94

In 1992 no significant differences in yield were observed between the treatments, although the yields seemed to decrease with an increasing *Poa*

annua density. There was no significant interaction of cultivar x *Poa annua* density. The trial will be continued, because the effects are likely to continue for several years.

B. The period of weed growth

In 1992 a trial was set up at the Experimental Stations Geldermalsen, Numansdorp and Zeewolde to study the effects on apple growth and production of different periods of weed growth. The results of this trial should lead to the elimination of weeds only in those periods when weed growth has a negative influence. The weeds in this experiment are the naturally growing vegetation.

The weed free periods are achieved by means of contact herbicides.

Table 103 shows the yields at the 3 sites.

Table 103. Yield per tree of several apple cultivars with different periods of weed growth.

Period of weed growth	Numansdorp* kg/tree	Geldermalsen** kg/tree	Zeewolde*** kg/tree
none	12.0	17.9	19.6
spring	12.3	20.5	17.4
summer	12.4	20.4	18.9
autumn	11.2	18.2	19.5
spring + summer	11.2	18.4	19.3
summer + autumn	12.8	20.0	17.8
autumn + spring	12.2	18.9	20.1
all year	12.3	19.3	17.9

* cultivar: James Grieve.

** average of cultivars Alkmene, Rode Boskoop and Cox's Orange Pippin.

*** cultivar: Fiesta.

No significant differences in production were observed in 1992. The effects may become visible after 1 or more years, so the trial will be continued.

ENTOMOLOGY AND BIOLOGICAL CONTROL

INTEGRATED CONTROL OF PEST OF APPLE

J. Woets, M.M. Giezen, W. Remijnse

Effect of Eupareen on integrated pest control

In 1992 a 2-years' study to investigate the effect of 2 scab schemes on the predatory mite *Typhlodromus pyri* was closed.

In 1991, the standard integrated scab scheme was compared with Captan and EBI-fungicides, as used for many years on the research orchard with the Bayer-advice: from flowering till picking time, every ten days 1.5 kg Eupareen per hectare was applied. Fruit tree red spider mite *Panonychus ulmi* was not found and apple rust mite *Aculus schlechtendali* was only found in small amount in Captan plots. The number of *T. pyri* in Eupareen-plots was so low that it was

doubtful if biological mite control could be satisfactory in 1992.

In 1992, all plots had the standard integrated scab control. During the season leaves were investigated. Fruit tree red spider mite was not found (Table 104).

Table 104. The average number of *T. pyri* and the average number of leaves with apple rust mite per 100 leaves.

Date	Number of predatory mite		Leaves with apple rust mite	
	1991 Captan +'92 Captan	1991 Eupareen +'92 Captan	1991 Captan +'92 Captan	1991 Eupareen +'92 Captan
1 May	34 a	3 b	7	4
20 May	22 c	9 d	3	5
26 June	39 e	21 e	7 a	27 b
24 July	92 f	111 f	7	17

On 20 May, Eupareen plots had significantly more *Tydeus* mites than Captan plots, 41 and 12 *Tydeus* mites per 100 leaves, respectively. It was not possible to prove a correlation between the number of *T. pyri* and *Tydeus*.

On 24 June, the number of *T. pyri* between the Eupareen replicates differed significantly more than between the Captan replicates.

In 1992 it was luck that none of the fields needed on acaricide to control apple rust mite. We don't know what would have happened in another orchard (other species, age of the trees etc.) in another year (other temperatures). The rebuild of the *T. pyri* population was satisfactory, and probably stimulated by the presence of apple rust mite.

Safety for predatory mite, of fungicides for fruit rot control

At the time of spraying against fruit rot control many predatory mites *Typhlodromus pyri* will all ready be at winter-hiding places on the trees. They pobably won't be harmed by the sprayings.

In 1991, 4 and 2 weeks before picking time some fungicides were sprayed in 7 replicates, on Jonagold. In September and May leaves were investigated. Fruit tree red spider mite *Panonychus ulmi* was not found. The number of apple rust mite *Aculus schlechtendali* and predatory mite *Tydeus* sp. was too low to mention. The number of predatory mites was not significantly different (Table 105).

Table 105. Average number of predatory mite *T. pyri* per 100 leaves.

Fungicide	Predatory mite	
	24 September 1991	13 May 1992
Topsin-M	66 a	27 a
Derosal	45 a	23 a
Carbendazim	63 a	24 a
Water	76 a	27 a

In integrated pest management the fruitgrower can use one of these fungicides twice for fruit rot control, without disrupting the biological mite control.

Organophosphorus insecticides and biological-mite control

Seven organophosphorus insecticides were investigated for safety for predatory mite, *Typhlodromus pyri*. They were sprayed before flowering (=practical spraying time) at 2 locations, and in July (=many predatory mites available) at 4 locations.

In all replicates (20), fruit tree red spider mite, *Panonychus ulmi* was absent.

Spring-treatment

Two weeks after spring-treatment only a few apple rust mite, *Aculus schlechtendali* were found. Note that after 12 weeks the smallest apple rust mite population was found at the fields which 2 weeks after treatment had the most predatory mites. And after 12 weeks the biggest apple rust mite population was found at fields which 2 weeks after treatment had the fewest predatory mites. Table 106 shows the number of predatory mites, 2 and 12 weeks after treatment. In every field predatory mite population was well recovered after 12 weeks, without any apple rust mite problem.

Table 106. Average number of *T.pyri* per 100 leaves, after spring-treatment.

Pesticide	2 weeks after spring-treatment	12 weeks after spring-treatment
Folimat	0.0 a	82.0 a
Ultracid	4.7 b	81.3 a
Ekatin	7.8 bc	80.6 a
Dimecron	8.0 a	69.3 a
Luxan Azinfos	8.3 bc	87.3 a
Water	8.5 bc	82.0 a
Hostaquick	9.3 c	80.0 a
Phosdrin mengolie	11.3 c	78.0 a

Summer-treatment

Ten days after treatment leaves were investigated. Apple rust mite was only found at 2 locations. There was no significant difference between the organophosphorus insecticides, in number of leaves with apple rust mite.

Table 107. Safety for predatory mite, *T. pyri*, 10 days after summer-treatment.

Pesticide	Average number of predatory mites, on 100 leaves	Reduction of predatory mites
Folimat	0.4 a	99 %
Ultracid	4.7 a	87 %
Dimecron	12.5 b	65 %
Phosdrin mengolie	21.3 c	40 %
Ekatin	23.7 cd	33 %
Hostaquick	23.8 cd	33 %
Luxan-Azinfos	29.4 de	17 %
Water	35.4 e	0 %

Table 107 shows the number of predatory mites and predatory mite reduction. Tydeus mites were found only at 2 locations. Fields with few *Typhlodromus pyri* show a lot of Tydeus mites, and also vice-versa. This was obvious, but it was impossible to prove a correlation between those 2 predatory mites.

T. pyri is resistant for some organophosphorus insecticides, so in a problem situation fruitgrowers can use one of these insecticides and take just a small risk of disrupting the biological mite control.

Every treatment with an organophosphorus or another broad spectrum insecticide will kill most of the other natural enemies like parasites, predatory bugs, earwigs, parasites, ladybirds etc.

Kilval and biological mite control

Kilval is a systemic insecticide especially effective against aphids. It is harmful to predatory mite *Typhlodromus pyri*. The possibility of a restricted Kilval treatment was investigated. In May, 5 replicates on Elstar were treated with water, Pirimor and Kilval. Kilval was applied in 3 different ways:

- 1) sprayed half tree
- 2) on 50 cm of bottom of the stem
- 3) on whole stem and a few big branches (without touching leaves)

Fruit tree red spider mite *Panonychus ulmi* was absent and apple rust mite *Aculus schlechtendali* was present, only in small amounts. Average number of predatory mite (Table 108) were not significantly different.

Table 108. Average number of predatory mite, *T. pyri* per 100 leaves.

Object	<i>T. pyri</i> 3 June	<i>T. pyri</i> 26 June	<i>T. pyri</i> 3 + 26 June
Water	16	18	17
Pirimor	30	25	28
Kilval 1	26	34	30
Kilval 2	46	19	33
Kilval 3	37	25	31

To spray half the tree with Kilval will probably be more effective against woolly aphid *Eriosoma lanigerum*, than the other Kilval treatments. It isn't more harmful to predatory mites than water and it is easily carried out by fruitgrowers.

Kilval like the other organophosphorus insecticides is harmful to most of the beneficial insects.

Earwig

The common earwig *Forficula auricularia* overwinters in sheltered situations in the soil. In June it starts moving from the soil into fruit trees. In an initial research earwig bags were placed in trees on soil and in trees on black woven polypropylene plastic. At the end of July earwigs from the bags were counted. The number of earwigs that moved into the trees seemed not to be influenced by the plastic soil cover.

INTEGRATED FRUIT GROWING

INTEGRATED FRUIT GROWING

A.M.E. Schenk

Materials and methods

The aim of the project Integrated Fruit Growing is the development of an economical production of apple minimizing the undesirable side effects for human health and the environment.

The experiment is located on 2 experimental gardens, Numansdorp and Zeewolde. At each location, a comparison is made between 3 systems of fruit growing (3 treatments): current, integrated and natural.

In spring 1990, 8 apple cultivars per treatment were planted in single rows (3 x 1.25 m), with every cultivar in 2 to 4 rows.

The apple cultivars are 6 current ones (Elstar, Jonagold, Alkmene, Cox's Orange Pippin, Discovery, Rode Boskoop), and 2 scab and mildew resistant hybrids from the CPRO (78039-18 and 78039-27). Every treatment is 0.5 ha per site.

In treatment 1 all legal treatment and techniques were used. Predatory mites were introduced and selective pesticides were used. Decision-making schemes for disease control were followed.

In treatment 2 lower dosages of pesticides were used. Only products allowed in ground water protection areas were sprayed. Weeds are controlled using a herbicide wick applicator to apply the herbicides instead of spraying it, and by special weed burners. As insecticides, products are used that are safe for predatory mites and also other predators. Decision-making schemes for disease control were followed.

In treatment 3 a minimized use of pesticides was tried replacing them with biological or mechanical techniques. Decision-making schemes for disease control were followed using lower dosages of fungicides.

Results

The results are the same for the 2 experimental gardens.

Plant protection in 1992

Insects and mites

Predatory mite (*Typhlodromus pyri*), rust mite (*Aculus schlechtendali*), spider mite (*Panonychus ulmi*).

A biological balance has been established with the following characteristics:

- no spider mite
- few rust mite
- few predatory mite

Rosy apple aphid (*Disaphis plantaginea*)

Rosy apple aphid has been found in Numansdorp (Nu) and Zeewolde (Ze) but was never a big problem. Treatment 1 and 2 are treated with 30 and 20 g Pirimor respectively.

Leafrollers (*Tortricidae*)

In treatment 1 no caterpillars were found and no treatment has been done for leaf rollers (incl. codling moth). (Table 102)

In treatment 2 and 3 the number of dispensers had been decreased from 500 to 300 per ha because damage was low (0.1 to 0.6 %). In detailed research in 1992 it has been proved that 300 dispensers is too few. In some cases the treatment was not effective enough.

Table 109. Treatment and damage of leaf rollers in 1992.

	Treatment		Damage in % production	
	Ze	Nu	Ze	Nu
Treatment 1	-	-	0.1	1.2
Treatment 2	pherom.	pherom.	0.2	1.0
Treatment 3	pherom.	pherom.	0.3	0.6

Orthosia sp.

The threshold level of 2 caterpillars per 100 clusters was reached in Zeewolde at the end of bloom. A treatment with diflubenzuron has been done in treatment 1 and 2. Damage at harvest was still high in the 3 treatments (Table 110).

Table 110. Treatment and damage of *Orthosia* sp.

	Treatment		Damage in % production	
	Ze	Nu	Ze	Nu
Treatment 1	diflub.	-	0.4	1.6
Treatment 2	diflub.	-	1.0	2.1
Treatment 3	-	-	3.0	1.7

Green capsid (*Lygus pabulinus*)

Table 111. Treatment and damage of green capsids in 1992.

	Treatment		Damage in % production	
	Ze	Nu	Ze	Nu
Treatment 1	-	-	0.0	0.1
Treatment 2	-	-	0.0	0.1
Treatment 3	-	-	0.0	0.4

Green capsid was not found. No treatment has been done. Damage in Numansdorp was maximum 0.4 % and in Zeewolde 0.0 % (Table 111).

Earwig (*Forficula auricularia*)

Controlling the sacks for earwigs, it became clear that the distribution of the earwigs is very heterogeneous in the parcel. In some trees a hundred earwigs can be found, in other trees only very few earwigs are found. This can be explained by the small amount of horizontal migration of the earwigs. The peak of the earwigs' population was reached in June-July in 1992.

Lacewing (*Chrysopa carnea*)

In treatment 3 boxes for lacewings have been placed. The aim was to give the lacewings a place to stay in winter. During the first year the boxes were filled with straw and the results were disappointing. Only very few lacewings were found. In a small experiment the boxes were filled with straw, woodwool and cardboard which had been cut into little pieces. Woodwool and cardboard gave better results than straw. This year this experiment will be repeated.

Diseases

Scab (*Venturia inaequalis*) and mildew (*Podosphaera leucotricha*)

Already in May high infection of scab was noticed.

Zeewolde : 2.5 - 4.5 %

Numansdorp: 9.0 - 62.0 %

In all parcels the same treatments have been done.

Treatments: Ze: 10 x penconazole (1.25 %) + captan (33.75 %) (150 g)
 8 x captan (83 %) (120 g)
 Nu: 6 x penconazole (1.25 %) + captan (33.75 %) (150 g)
 1 x penconazole (1.25 %) + captan (33.75 %) (200 g)
 2 x bitertanol (25 %) (80 g)
 18 x captan (83 %) (120 g)

In Zeewolde no treatment against mildew was done except for the penconazole treatment against scab. In Numansdorp 8 treatments with nitrothal-isopropyl were done.

Again this year big differences in susceptibility between the different

Table 112. Different susceptibility of the cultivars for scab. Infection in % scab on the fruits at harvest.

	Treatment 1		Treatment 2		Treatment 3	
	Nu	Ze	Nu	Ze	Nu	Ze
Elstar	30.8	31.8	23.1	33.2	43.8	31.9
Jonagold	56.5	27.0	36.4	27.0	55.2	27.1
Alkmene	6.2	11.2	13.2	12.2	11.5	10.8
Cox's O.P.	1.8	3.0	2.9	3.3	3.6	1.3
Discovery	2.1	1.0	7.6	2.3	2.8	2.1
Rode Boskoop	2.9	7.6	33.8	9.1	15.4	13.0
CPRO 78039-18	0.0	0.0	0.2	0.2	0.0	0.0
CPRO 78039-27	0.0	0.0	0.1	0.0	0.0	0.0

cultivars have been noticed (Table 112).

On the 2 CPRO cultivars that are resistant for scab and slightly susceptible to mildew no treatment has been done. No scab is noticed here.

Storage diseases were treated completely in treatment 1, partially in treatment 2 and not at all in treatment 3. The fruits were stored in ULO. At the sorting in December and February no differences were found between the 3 treatments, even after 2 weeks at 20 °C.

Fruit tree canker (*Nectria galligena*)

Against fruit tree canker captan treatments are done in treatment 1 and 2. In treatment 3 only canker wounds have been cut out. In winter 1992-1993 the damage was counted (Table 113).

Table 113. Treatment and damage of fruit tree canker in 1992.

Treatments against canker	Number of canker wounds in Dec. 1992	
	Nu	Ze
Treatment 1: 2 x 187.5 g Captan	29	33
Treatment 2: 2 x 125 g Captan	26	35
Treatment 3: -	30	56

Weed management

Treatment 1: Simazin, diuron and glyphosate were used. In 1993 simazin has to be replaced by another herbicide because of its effect on the environment. No problems were noticed.

Treatment 2: The herbicide wick applicator was satisfactory. One spraying at 5 l/ha and several treatments with the herbicide wick applicator at 2 l/ha was enough to keep weeds away. Two weeds gave problems: *Cardamine hirsuta* and *Epilobium hirsutum*. *Cardamine* is resistant to glyphosate and the herbicide wick applicator cannot touch *Epilobium* thoroughly. The herbicide wick applicator has one big disadvantage: driving speed must be slow enough e.g. 2 km/h. This speed probably can be higher.

Treatment 3: Weed burning is not satisfactory: It takes too much time and needs a lot of replications per year. Polypropylene cloth has some big advantages: little work is needed for weed management and very little herbicide is used. It also has some disadvantages: near the tree and at the boards some herbicide treatment is needed. For this treatment sometimes the same amount of herbicide is used as for the treatments with the herbicide wick applicator, so the herbicide wick applicator is better for the environment.

Use of pesticides

Table 114. Use of pesticides (in g a.i./ha) in 1992 in Numansdorp and Zeewolde.

	Treatment 1	Treatment 2	Treatment 3
<u>Numansdorp</u>			
fungicides	29005	26178	20987
herbicides	4496	549	372
insect./acaricides	300	200	200
Tot. plant protection	33801	26927	21559
<u>Zeewolde</u>			
fungicides	22170	20060	16410
herbicides	3160	1300	185
insect./acaricides	350	300	0
Tot. plant protection	25680	21660	16595

Use of growth regulators

In choosing the type of growth regulation for the 3 treatments, the decision is based on the following subjects: in treatment 1 all legally approved growth regulators are used, if necessary. In treatment 2 carbaryl is omitted because it kills natural enemies being also a broad spectrum insecticide; in treatment 3 only GA 4+7 is used and thinning is done by hand (Table 115).

Table 115. Use of growth regulators (in g a.i./ha) in 1991 in Numansdorp and Zeewolde.

	Treatment 1	Treatment 2	Treatment 3
GA 4+7	10	10	10
(All cultivars 2 x)			
Carbaryl	63	0	0
(Alkmene 100 g)			
1-naftylacetamid	55	55	0
(All cvs except Alkmene)			
Total growth reg.	128	65	10

Use of the environmental yardstick for pesticides

In choosing pesticides and growth regulators the environmental yardstick for pesticides is used. This yardstick makes it possible to compare the effects of different pesticides on soil organisms, water organisms and leaching to ground water. In 1992 it became clear that the choice in integrated pest management is small. Still, it is possible to improve a lot by choosing the right pesticides. Since the data of the yardstick are still confidential, results will be reported later on.

Fertilization

Before planting in treatment 3, stable dung at 80 and 40 tons per ha was

used in Numansdorp and Zeewolde respectively. In 1990 a normal fertigation scheme was followed. In 1 and 2 Kristalon lilac was used, in 3 ureum was fertigated. In the 3 parcels 15 g nitrogen per tree was given. In 1991, based on soil analyses it was decided only to fertigate in Zeewolde under dry conditions and in Numansdorp to add only 7.5 g nitrogen per tree.

In 1992 19 g nitrogen per tree was fertigated, based on leaf analyses. In Zeewolde no fertigation was given.

Nutrient and pesticide leaching

In 1989 detailed research on leaching of pirimicarb and simazin was done. This research was done by the Winand Staring Centre and has just been finished. Literature was studied on pirimicarb in which it was concluded that data of leaching of pirimicarb differed too much to give an estimation of the risk of leaching. (Leistra, M., 1992. Interne mededeling 225 DLO-Staring Centrum juli 1992 (in Dutch)).

Afterwards a labtest was done. Results are published in 1993. (Romero Taboada, E. et al., 1993. Adsorption, transformation and leaching of the insecticide pirimicarb in orchard soils. DLO The Winand Staring Centre, Wageningen).

A third research focused on simazin leaching to ground and drain water. In Numansdorp the concentration of all samples was below the EC level for drinking water i.e. 0.1 µg/l. In Zeewolde 68 % was below 0.1 µg/l, 91 % was below 0.2 µg/l. (Leistra, M. et al., 1992. Measurements for the herbicide simazin in ground water in two fruit growing parcels. (In Dutch)).

Production in 1992

In Zeewolde production was lower in treatment 3 because of the problems in 1991: concurrence of weeds and rust mite resulted in fewer flowerbuds. In Numansdorp no differences were noticed. In treatment 3 more damage at harvest occurred, by scab and by *Orthosia sp.* (Table 115).

Table 115. Production in 1992.

	Zeewolde			Numansdorp		
	Treatment			Treatment		
	1	2	3	1	2	3
Growth in m/tree	19	18	19	12	8	14
Production in t/ha	55	58	42	29	26	28
Insect damage in % production	0.7	1.7	4.8	4.1	4.0	4.7
Scab damage in % production	7.8	8.6	8.4	13.6	18.8	19.3

Labour

All labour except observation time is recorded during 1992. In Table 110 it is clear that in Numansdorp most labour is needed in treatment 2. Using the herbicide wick applicator takes most of this time.

For picking 135 kg/h and for sorting 100 kg/h were estimated.

Table 117. Labour per treatment (man-hours/ha) in 1992.

	Treatment 1	Treatment 2	Treatment
<u>Numansdorp</u>	598	613	548
Excl. pick. and sort.	217	279	184
<u>Zeewolde</u>	1032	1051	774
Excl. pick. and sort.	200	200	190

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