# ORGANIC FRUIT GROWING



# Annual report 2003 LBI organic fruit growing research

including plans for 2004

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LOUIS BOLK INSTITUUT

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# 1 General

## 1.1 Organic fruit growing in 2003

To put our work into context we will first outline some important developments in the organic fruit sector.

### Hectarage and production in 2003

This year for the first time there was a decline in hectarage: three orchards ceased production of organic fruit. Two of them did not see any future for their orchard in organic production. For the third orchard business take-over proved financially impracticable. No new orchards went into organic production.
For the organic arboriculturists, who had invested in the development of organic starting material in anticipation of compulsory use in 2004, it is hard to accept that the competent authority continues glibly to grant exemptions. The number of organic arboriculturists thus decreased to just one in the Netherlands and Belgium.
According to the Skal survey there were 448 hectares of hard fruit and 63 hectares of soft fruit in the Netherlands in 2003.

### Sales and growers' association

All organic fruit together represented 1.7% of the turnover of conventional fruit in 2003 (source: Ekomonitor). Fifty percent of this was sold through supermarkets. Total production was reasonable but not excessive and it is likely that market will be able to absorb the produce grown.
This year a Prisma chain workgroup operated under the leadership of chain manager Wouter van Teeffelen. This group, which represented all sales combinations and a number of independent growers, attempts to harmonise and improve the growers' sales and quality policy.
It is becoming increasingly clear to many people that market development requires good coordination, and cooperation between producers themselves and with the market players in the different chains. In the past year clear advances have been made in this area under the direction of the chain manager. Until late December the continuation of the post of chain manager was still in doubt for financial reasons.

### Approval of control agents

The lack of a comprehensive package of crop protection products continues to hamper the organic fruit growers. The sector has now clearly chosen to go down the route of conversion to scab resistant varieties, in an attempt to decrease dependency on control agents. We expect the main effect of this to be a reduction in the volume of crop protection products. We do not expect the sector to be able to manage with a narrower range of products. On the contrary: a broader range of control agents could contribute to a reduction in the overall volume used. The Organic Fruit Crop Protection Commission and interested individuals have worked hard in the past year on applications for approval and on formulating proposals for a coherent systematic approach in crop protection policy for the sector. New approvals this year included powdered sulphur for pear and Neem Azal t/s. There was temporary exemption for the use of lime sulphur until flowering in 2003. An application has been submitted to the EU to include calcium hydroxide in Annex 2B.

## 1.2 Characteristics of the 2003 season

### Weather

We had a very moderate winter. In January there was still a lot of rain, then in February and March it was extremely dry and sunny. There was night frost at the beginning of April (5,6 and 8 April), which may have contributed to the heavy fruit russeting this year. April was dry and warm. In mid-May there were two rainy weeks followed by a heatwave. On 4 June there were local hailstorms. By mid-June it was really warm again.
The summer months of July and August were also characterised by dryness and heat. Many plots suffered from drought stress. Despite heat and drought there was remarkably little sunscald on the fruit. The berry and plum harvests were good. Hard fruit was picked almost a week earlier than usual. At the beginning of September there was some further rain, after which the rest of the harvest was done in dry weather. The autumn was reasonably dry with good conditions for tillage, canker spraying, grubbing up and preparations for planting.

### Pests and diseases

Thanks to the many dry and warm periods scab was not a problem this year. On the other hand managing insect damage was much more troublesome this year. Many orchards suffered a lot of unexpected damage from Apple Sawfly. Despite the use of a mating disruption pheromone, a number of orchards had a lot of damage from codling moths. Plum fruit moths caused a great deal of local damage. There was also a strikingly large number of apple fruits on many plots visibly affected by Monilia in the summer.

### Fruit quality

Plenty of sunshine this year made the fruit exceptionally sweet. The down side of the fair weather was the tardy colouring on apple and the rapid ripening during harvest. In many cases the pickers could not keep pace with it. As a result many batches of apples could not be harvested as early as they should have been. The fruits on many plots were fairly large this year because the crop was often on the light side. Many batches of apples already had minimal firmness at the point of entry into storage, and this was clearly reflected in the market at the beginning of the season: moderate eating quality and pressure on the retail market because growers wanted to get the last picking off their hands as quickly as possible.

### Sales

It is still very important to continue to develop the domestic market. Sales through supermarkets are growing, but the overall volume is still limited. We have high expectations of the new scab resistant varieties for a profitable crop and to meet the external quality requirements imposed particularly by the supermarket channel. Unfortunately we once again found that new varieties like Santana which are unfamiliar to the consumer are not readily accepted. It would seem advisable to pay greater attention to the introduction of new varieties. Due to the tight domestic market it would be worthwhile to store good apples for a long period so that they could be exported when the German market begins to dry up. Such a long storage period leads to major storage losses in the case of inferior batches. This should not really be necessary.

## 1.3 Research by the LBI

The LBI primarily selects projects involving close cooperation with organic fruit growers. The role of the growers is to provide their orchard as a practical context for the research, to help the researchers develop a relevant experimental design, to carry out some of the practical activities and to assist in the evaluation of the results. In addition, the LBI selects fundamental research projects that focus on innovative issues relevant to organic agriculture. In fruit cultivation, our main emphasis is still on apple and pear, focusing specifically on growth regulation and fruit bearing, soil management, scab and canker, fruit quality and sales. The institute is currently investing across the board in research in new areas of product quality and socio-economic research in agriculture. The institute works closely with *Prisma* (the Dutch growers' association), *PPO Fruit* (Institute for Applied Plant Research, Fruit Section), and agricultural consultants *DLV* and *Biofruitadvies*.

Fruit growing research at the LBI was carried out in 2003 by Joke Bloksma (senior researcher), PieterJans Jansonius (researcher), Marleen Zanen (researcher) in collaboration with fruit growers Henri Albers, Florian de Clercq, Harrie van de Elzen, Jaap Flikweert, Anton Haalboom, Robin Kars, Kees Konijn, Piet Korstanje, Hans Levels, Gerard van Noord, Harald Oltheten, Harmen Peters, Paul van der Poel, William Pouw, Louis Ruissen, Wim Stoker, Wil Sturkenboom, and Dirk van Ziel. The research was also supported by many unseen staff at the LBI (in administration, acquisition, IT, statistics, lay-out, soil research, flavour research, picture developing methods, publication sales, etc.).

### The Fruit Growing Section at the LBI will be smaller in 2004

Despite the fact that organic fruit growing is incorporated into policy objectives in many places, we have still been unable to find sufficient funding to continue at this level of expertise in the coming year. The growers' association Prisma clearly indicated that it found this very regrettable as it considered that the LBI researchers involved had provided major support to the sector. In 2004 PieterJans Jansonius will head the section with Marleen Zanen as a researcher and Joke Bloksma will take a year out. Recruitment is aimed at a fruit section large enough (around 1.5-2.5 Full time units) to maintain sufficient contact with growers in the field and the international research network.

Overview of projects, funders and partners in 2003 and plans for 2004

1. 'Improvement in production in apple and pear', a project related to the research at the PPO into nitrogen provision in organic fruit growing. The objective is to design and evaluate practical measures to regulate mineral uptake, and balance growth and fruiting, anticipating such sudden or unexpected events as frost, drought, extreme rainfall or biennialism. The project is funded by the Ministry of Agriculture, Nature and Food Quality and falls under the Advisory Committee of the PPO programme 'sustainable fruit growing and fruit tree arboriculture / nursery'. This project culminated in 2003 with the publication of a handbook.
2. 'Fruit tree canker', various small projects in fruit and fruit tree growing, partly in collaboration with PPO, the Fleuren nursery and LaMi (Agriculture and Environment Foundation). Funding by the Horticulture Marketing Board (PT), Fleuren Demonstration Orchard and Organic Tree Nursery. LBI internal projects funds.
3. 'Classy Apples' (2000-2003) and 'Classy Apples in the Chain' (2003-2004), projects aimed at improving the internal and external quality of organic apples in collaboration with growers, trade, information services, the Institute for Applied Plant Research Fruit (PPO) and Nijenrode University. Funded by growers, trade, Rabobank and Ministry of Agriculture, Nature and Food Quality's DWK (Department of Science and Knowledge Dissemination) and AKK (Agriculture Chain Knowledge Foundation).
4. 'Parameters for apple quality': Fundamental methodological project on useful criteria for internal quality for the organic market. Contribution of its own funds by LBI, the Triodos-bank, Software Stiftung (D), Rabobank and investment by partners Boomgaard ter Linde (NL), Kwalis (D), Heilmann (D), Hertha (DK) and Meluna (NL). Completed.
5. Working group on organic fruit growing. LBI provides the secretariat. Partly financed by a contribution from the Marketing Board through *Biologica* and otherwise from LBI funds.
6. Small assignments. Financed by private individuals and assignments by partners, presentations, excursions, seminars, lectures in the Netherlands and abroad, commentary on drafts, advice to private orchards.

# 2 Soil management

## 2.1 General

Our objectives in soil management research combine a number of issues: soil fertility, production, fruit quality, growth regulation, prevention of night frost damage, leaf decomposition (scab) and practical feasibility. This will result in different regimes of weed control, fertilisation, foliar feeding and watering for each plot. The evaluation criteria remain particularly difficult to assess. The proposed revised edition of the soil book (LF39) is combined with the final publication of the regulation project which appeared in de winter of 2003 as a handbook "*Biologische Appels en Peren – teeltmaatregelen voor kwaliteitsfruit*-" (Organic apples and pears – cultivation measures for quality fruit) (LF75, ed. Joke Bloksma).

## 2.2 Type and quantity of fertiliser

The Ter Linde Orchard is looking for a middle way between using large quantities of fertiliser for strong flower buds and small quantities for high quality fruit, and would also like to economise on fertiliser. There was also the issue of whether home-composted cow manure with biodynamic preparations was better for the soil or fruit quality than the easily applied commercial fertilisers which can be bought premixed and ready to use. Over a period of three years different quantities of fertiliser are applied based on readily available commercial fertilisers (combination of Maltaflor and chicken manure pellets) and one treatment with home-made cow manure compost. The fruit quality is evaluated in the second year.

***Multi-year fertilisation trial on mature Elstar at the Ter Linde Orchard 2001-2003***.

| Dosage / ha in spring 2001, 2002, 2003 | Growth rate | flow-ering rate | fruit-ing rate | % blush fruit | Firm-ness fruit | Brix fruit | acidity fruit mg / l | mg N fruit 100g | % Fruit rot |
|---|---|---|---|---|---|---|---|---|---|
| Date: month-year | 8-'02 | 4-'03 | 8-'03 | 9-'02 | 9-'02 | 9-'02 | 9-'02 | 9-'02 | 3-'03 |
| Target value | 5 | 5-7 | 10 | >50 | | >12 | 9-10 | <45 | 0 |
| Unfertilised | 6.7 | 3.5 | 4.0 | 60 | 7.3 c | 12.9 a | 8.5 a | 34 a | 2.6 a |
| 40 kg N chicken / Maltaflor | 7.0 | 4.4 | 6.1 | 58 | 7.2 b | 12.8 a | 9.2 b | 39 ab | 3.3 a |
| 80 kg N chicken / Maltaflor | 7.0 | 5.4 | 5.8 | 45 | 7.1 ab | 12.7 a | 9.3 b | 41 c | 3.7 a |
| 120 kg N chicken / Maltaflor | 7.1 | 6.9 | 7.4 | 43 | 7.0 a | 12.7 a | 9.5 b | 43 c | 3.6 a |
| 160 kg N chicken / Maltaflor | 7.4 | 7.7 | 7.5 | 38 | 7.0 ab | 12.7 a | 9.5 b | 45 c | 7.1 b |
| 100 kg N cow manure compost | 6.8 | 5.0 | 5.9 | 63 | 7.3 bc | 12.8 a | 9.2 b | 40 b | 3.0 a |

Each object of treatment consists of a small field of ten trees in four replications. Cropping was standardised in 2001 and 2002 by early hand thinning to around 110 fruits / tree. Various letters after the averages indicate a 95% certain difference.

| Dosage / ha in spring 2001, 2002, 2003 | Fungi / bacteria soil | % Leaf decomposed on soil |
|---|---|---|
| Date: month-year | 4-'03 | 3-'03 |
| Target value | 5-10 | 100 |
| Unfertilised | 3.4 | 57 a |
| 40 kg N chicken / Maltaflor | * | 67 ab |
| 80 kg N chicken / Maltaflor | * | 65 ab |
| 120 kg N chicken / Maltaflor | 2.8 | 71 ab |
| 160 kg N chicken / Maltaflor | * | 64 ab |
| 100 kg N cow manure compost | 4.7 | 79 b |

Differences in nitrogen levels could already be observed in the leaf in the first year of the trial with different levels of fertilisation. The difference was greatest in the third year, although it is amazing how such large differences in fertilisation levels have relatively little effect on the trees. Trees are less affected by varying fertilisation levels than vegetable crops.

Nitrogen from compost enters into the tree at a slower rate than from chicken pellets with Maltaflor. The trees treated with compost are similar to unfertilised trees at the beginning and after a few years of medium application levels they resemble fertilised trees with a relatively good fruit quality. Compost has a beneficial effect on soil life: most leaf decomposition in the spring (good for reducing overwintering of scab) and a slight shift from soil bacteria to more soil fungi. To promote leaf disintegration the use of compost is more significant than the amount of fertiliser. In practice a combination of compost in autumn and commercial fertilisers in the spring is also a good option. We found little difference in fruit quality between apples fertilised with different types of manure.

The 120 kg N treatment was an optimum fertiliser level for the crop in this orchard (with a soil type which retains nitrogen), sufficient for flower bud formation and fruiting in 2003 and still with a relatively good fruit quality, including flavour. More fertiliser, 160 kg N, produces too much growth and a poorer fruit quality. Less fertiliser led to inadequate flower bud formation for 2003. In 2003 many of the unfertilised trees had an off year accompanied by excessive growth. The fruits of the unfertilised fields showed characteristics of emergency ripening (ripe earlier, sweet, flat, a lot of blush). The fruits which received excessive fertilisation (160 kg N)

show an accumulation of free nitrogen compounds, have few phenols, calcium and red blush, are less firm and extra susceptible to fruit rot. This loss of quality is the risk attached to applying large doses of fertiliser unnecessarily. These results are part of a larger project, about which a scientific report will be published in spring 2004, see LBI FQH-04 in the literature list.

## 2.3 Level of fertiliser application

### Level of fertilisation

A multi-year trial has been set up in 4 replications on poor soil at the Ter Linde Orchard to determine whether different doses of poultry manure granules can be used to achieve an optimum level with little risk of night frost damage, reasonable production and good fruit quality. This trial has been running since late summer 2000.

**Progress of the trial**:
Following a poor fruiting year in 2001 we saw no difference in flowering in 2002. After a normal fruiting year in 2002 we do however see a developing trend of higher doses of fertiliser leading to the formation of more buds. Last year the higher doses produced a slight trend towards more growth. The larger number of flowers at the two highest doses also led to better fruiting in 2003.

***Growth flowering and fruiting rates in late summer fertilisation trial with Elstar, Ter Linde Orchard.***

| treatment | flowering rate 2002 | growth rate 2002 | fruiting rate 2002 | flowering rate 2003 | fruiting rate 2003 |
|---|---|---|---|---|---|
| 0 | 9.8 | 6.0 | 9.1 | 2.3 | 3.7 |
| 44 kg N/ha | 10 | 6.1 | 9.4 | 2.3 | 3.0 |
| 88 kg N/ha | 9.5 | 6.6 | 9.1 | 4.0 | 5.2 |
| 132 kg N/ha | 9.8 | 6.8 | 9.6 | 4.3 | 5.4 |

This year again higher fertilisation levels led to better nitrogen content in bud and leaf. The differences in bud analyses were less clear than in 2002. These results coincide with the application time trial described in section 2.3. Treatment 4 in this trial had the same application time and this year again failed to produce the good results of previous years. In the August analysis the highest nitrogen level did not appear to make much further contribution. The usual target value for nitrogen in the leaf was not achieved on this plot, not even in the case of 132 kg N over a period of 3 years.
A higher fertilisation level led to a reduction in fruit quality and delayed ripening. The nitrogen content in fruit was not too high anywhere. At the highest level it seems this year that the advantages did not outweigh the disadvantages.

***Bud and leaf analyses and fruit quality in late summer fertilisation trial with Elstar, Ter Linde Orchard, 2003.***

| | from 2000 late summer fertilisation | %N bud | % N leaf | % K leaf | mg N fruit | mg K fruit | mg Ca fruit | firmness fruit | Brix fruit | acidity fruit |
|---|---|---|---|---|---|---|---|---|---|---|
| | **month-year→** | **3-03** | **8-03** | **8-03** | **9-03** | **9-03** | **9-03** | **9-03** | **9-03** | **9-03** |
| | target→ | ??? | 2.25-2.5 | 1.35-2.0 | <50 | high | >5 | >7 | >12 | 9-10 |
| 1 | 0 | 1.64 | 1.45 | 2.09 | 28.9 | 175 | 4.7 | 9.4 | 14.9 | 8.8 |
| 2 | 44 kg N/ha | 1.64 | 1.70 | 2.07 | 33.1 | 167 | 4.8 | 8.5 | 15.0 | 9.7 |
| 3 | 88 kg N/ha | 1.75 | 1.99 | 1.79 | 41.9 | 174 | 4.9 | 8.1 | 14.7 | 8.6 |
| 4 | 132 kg N/ha | 1.76 | 2.00 | 1.79 | 40.5 | 156 | 4.4 | 7.8 | 13.5 | 8.4 |

## 2.4 Timing of fertilisation

### Timing of fertilisation with poultry manure

A trial has been running since 2001 on the Lijdijkweide plot at the Ter Linde Orchard in 4 replications with 5 different application times for fertilisation with 132 kg N / ha in the form of poultry manure granules. The object is to track developments in productivity and fruit quality for several years. Under the HACCP standards animal manuring is not permitted in the last three months before harvest, so the trial will have to be suspended in the summer unless vinasse (plant-based fertiliser) is used.

The treatments chosen are: 1. unfertilised, 2. Jan / Feb., (as in Germany), 3. Mar / Apr., (as normal in the Netherlands), 4. mid-June (HACCP), 5. beginning of August (advice from Jan Peeters, not under HACCP) and 6. immediately after harvest. We analyse buds (March), leaves (August) and fruits (September) and evaluate growth and flowering of the trees and the development of weeds under the trees.

**Provisional conclusions**:

Fertilising late in the summer leads to higher N, P and K levels in the buds (see table 2.1).

In 2003 it could not be demonstrated that these better nourished buds also lead to heavier cropping. There was however a better fruit set at higher levels but after the fruit drop this advantage was already lost. It is possible that this does happen following a heavy night frost (see table 2.3).

To date there is no clear difference between the treatments in the flower formation, except for the unfertilised treatment which had a clear off year in 2003 (see table 2.4).

Application in June led to a clear increase in the nitrogen content in the fruits. We regard this increase of around 40 mg N per kg fresh product in the other treatments to 50 mg / kg in treatment 2 as undesirable.

This research to date shows that apple trees still take up large quantities of nutrients late in the season: an application of chicken manure after harvest leads clearly to higher nutrient levels in buds. Without further applications these trees also have a good leaf condition in August (see table 2.2). The advantage of fertiliser application at this time – compared to spring application - is that it does not stimulate the growth of weeds as much (see table 2.5).

***Table 2. 1: Effect of timing of fertiliser application on nutrient levels in buds (beginning of March) 2002-2004, Trial BtL LW12.***

| **Treatment** | **N** | | | **P** | | | **K** | | |
|---|---|---|---|---|---|---|---|---|---|
| | % dm | % dm | % dm | %s dm | % dm | % dm | % dm | % dm | % dm |
| | 2002 | 2003 | 2004 | 2002 | 2003 | 2004 | 2002 | 2003 | 2004 |
| Treatment 1. unfertil-ised | 2.43 | 1.66 | 1.53 | 0.44 | 0.36 | 0.32 | 1.43 | 1.10 | 0.75 |
| Treatment 5. Jan. / Feb | * | 1.74 | 1.83 | * | 0.36 | 0.34 | * | 1.09 | 0.81 |
| Treatment 6. March / April | * | 1.79 | 1.95 | * | 0.38 | 0.36 | * | 1.13 | 0.87 |
| Treatment 2. July | 2.74 | 1.97 | 2.02 | 0.47 | 0.39 | 0.34 | 1.54 | 1.18 | 0.87 |
| Treatment 3. August | 2.82 | 2.10 | 2.24 | 0.45 | 0.40 | 0.36 | 1.54 | 1.22 | 0.93 |
| Treatment 4. Begin-ning of October | 2.95 | 2.25 | 1.86 | 0.46 | 0.39 | 0.33 | 1.55 | 1.23 | 0.82 |

*Table 2.2: Effect of timing of fertiliser application on nutrient levels in leaves, 2002-2003, Trial BtL LW12.*

| | August 2002 | | | | | August 2003 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Treatment** | **N** | **P** | **K** | **Mg** | **Ca** | **N** | **P** | **K** | **Mg** | **Ca** |
| | % dm | % dm | % dm | % dm | % dm | % dm | % dm | % dm | % dm | % dm |
| | 2002 | 2002 | 2002 | 2002 | 2002 | 2003 | 2003 | 2003 | 2003 | 2003 |
| targets | 2.25-2.50 | 0.20-0.30 | 1.35-2.00 | 0.22-0.35 | >1.20 | 2.25-2.50 | 0.20-0.30 | 1.35-2.00 | 0.22-0.35 | >1.20 |
| 1. Unfertilised | 1.74 | 0.43 | 2.05 | 0.16 | 1.50 | 1.59 | 0.39 | 2.00 | 0.17 | 1.23 |
| 5. Jan / Feb | 1.75 | 0.41 | 2.09 | 0.17 | 1.88 | 1.89 | 0.31 | 1.87 | 0.21 | 1.46 |
| 6. March / April | 1.83 | 0.42 | 2.13 | 0.17 | 1.84 | 2.03 | 0.29 | 1.83 | 0.21 | 1.56 |
| 2. mid-June | 1.88 | 0.32 | 1.89 | 0.19 | 1.66 | 2.10 | 0.32 | 1.89 | 0.22 | 1.57 |
| 3. August | 1.99 | 0.37 | 1.89 | 0.20 | 1.79 | 2.01 | 0.34 | 1.98 | 0.24 | 1.60 |
| 4. Beginning of October | 1.95 | 0.32 | 1.90 | 0.21 | 1.90 | 1.99 | 0.28 | 1.89 | 0.22 | 1.48 |

*Table 2.3: Effect of timing of fertiliser application on fruit set and drop, 2003, Trial BtL LW12.*

| | | | Count branch data average | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Treatment** | **N bud 2003** | **Flowering rate '03** | **#clusters** | **#flower** | **flower / cluster** | **% fruit set** | **% drop** | **#fruit / 100 clus.** | **#fruit / 100 flower** |
| 1 unfert. | 1.66 | 3.4 | 14 | 56 | 4.0 | 52 | 39 | 124 | 31 |
| 6 Mar / April | 1.79 | 7.3 | 26 | 111 | 4.2 | 68 | 58 | 116 | 28 |
| 4 begin Oct. | 2.25 | 6.7 | 28 | 117 | 4.1 | 72 | 57 | 126 | 31 |

*Table 2.4 : Effect of timing of fertiliser application on flowering and bearing rates, Trial BtL LW12, 2002-2003.*

| **Treatment** | **flowering 02** | **bearing 02** | **flowering 03** | **bearing 03** |
|---|---|---|---|---|
| 1. Unfertilised | 9.8 | 8.9 | 3.4 | 5.3 |
| 5. Jan / Feb | 10.0 | 7.6 | 7.4 | 9.0 |
| 6. March / April | 9.6 | 7.2 | 7.3 | 8.6 |
| 2. mid-June | 10.0 | 9.1 | 5.6 | 7.2 |
| 3. August | 9.7 | 8.3 | 6.9 | 8.6 |
| 4. Beginning of October | 9.4 | 8.3 | 6.7 | 8.9 |

*flowering rates on a scale of 1-10, **bearing rates on a scale of 1-15.

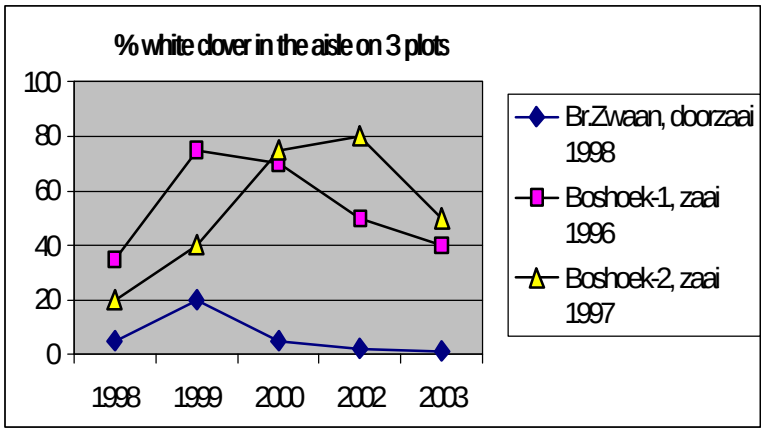
*Table 2.5: Effect of timing of fertiliser application on weed cover, Trial BtL LW12, spring 2003.*

| | **Date last application** | **weeds in tree strip** | | |
|---|---|---|---|---|
| | | **mass*** | | **grass colour**** |
| **Treatment** | | **26-Apr-02** | **14-Apr-03** | **14-Apr-03** |
| 1. Unfertilised | * | 2.7 | 2.2 | 1.3 |
| 5. Jan / Feb | 27-1-03 | 8.1 | 7.5 | 3.0 |
| 6. March / April | 28-3-03 | 3.2 | 4.6 | 2.8 |
| 2. mid-June | 4-7-02 | 4.0 | 2.6 | 2.0 |
| 3. August | 19-8-02 | 3.0 | 1.9 | 2.3 |
| 4. Beginning of October | 31-10-02 | 4.8 | 4.3 | 2.3 |

*mass = % cover x height / 100,**grass colour:1=light, 2=medium, 3=dark

## 2.5 Building up soil fertility under the aisle

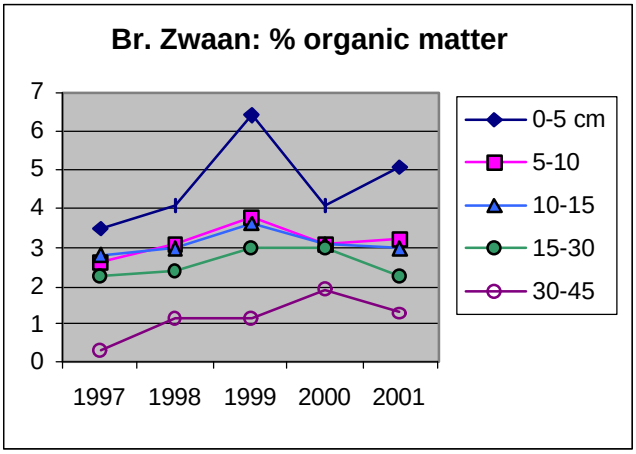
One of the objectives of organic agriculture is to maintain, or if possible, improve soil fertility with the minimum of external fertilisers. For this reason many organic fruit growers sow the aisles with a mixture of orchard grasses with extra white clover. At the Ter Linde Orchard we have monitored the proportion of clovers in the aisle and measured the soil fertility at various depths on three different plots over a period of years.

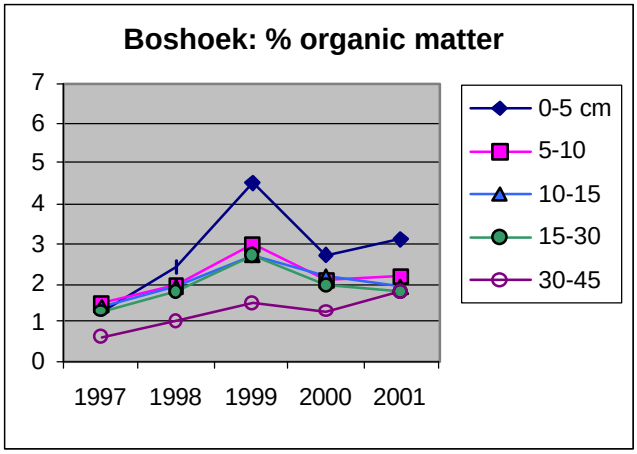



The percentage of clover in the aisle declines in a maturing orchard. Maximum clover cover is reached in the third and fourth year after sowing. In the older plot, Briesende Zwaan, a slight increase was achieved one year after reseeding with clovers, but there was a decline again in the following year. Reseeding with clover seemed not to have been worthwhile in this case. The aisle is probably no longer suitable for clover due to soil compaction and shade.

[*in graphics above*: doorzaai = reseeded; zaai = seeded]

Over the years the organic matter does in fact increase in all plots and at all depths. The high figures for 1999 can be explained by a lot of grass and litter at the time of sampling. Thus there is a build-up in soil fertility under the aisle, just as we know is the case with grassland. In this respect the Briesende Zwaan plot, with a long tradition of biodynamic management, has a considerable advantage in this over the recently converted Boshoek plot. But even at Boshoek the increase from 1 to 2 % extra organic matter in five years is considerable. This is an argument for making the aisle as wide as possible in relation to the clean cultivated strip. There is a clearly falling gradient in organic matter with depth; less so for nitrogen and potassium. An internal report has been published on this, which is available on request.




# 3 Balancing growth and crop

## 3.1 General

Time after time our research shows that good crop regulation is the basis for a quality crop. This applies to all varieties, but Elstar requires special attention because of its susceptibility to biennialism. This last year lime sulphur was available for controlling scab. This enabled us to benefit from the side effects of blossom thinning. Trials are still being run internationally on new thinning agents for organic growing. To date however there is

no prospect of a more efficacious agent than lime sulphur without the undesirable side effects. This begs the question of how much more energy should be spent on this research. We take the view that there are other areas to be developed which are essential to good crop regulation. There is scope for further development of an adapted pruning method which very specifically anticipates the prospects for the coming year. Pruning also seems to be important for the new variety Topaz, while we still need to ensure that we get sufficient fruit on the tree.
Many trials in which we monitor flowering and bearing rates show time and again that Elstar trees with slightly excessive growth levels have much poorer flowering rates in the following year, even where there is no excessive vigour. Thus much attention still needs to be paid to growth regulation.

## 3.2 Measures to control biennialism in Elstar

This spring we saw the first results of a demo trial combining various methods of thinning in three orchards to break a cycle of biennialism in Elstar. Previous research has clearly shown that Elstar cannot be brought out of an alternate bearing year solely by means of blossom thinning with lime sulphur. It requires additional measures such as extra pruning of fruiting spurs and timely hand thinning. Timely hand thinning is a serious organisational problem for the orchards. The issue for people in the field is whether, through a combination of pruning or by opting for a slightly lower cropping level, the time for hand thinning can be postponed until after the natural drop (see also 2002 Annual Report).

In 2002 a large demonstration trial was set up at three orchards (Albers, van Noord, Korstanje) combining various measures: thinning or not thinning with two or three applications of lime sulphur, adapted pruning (except at Albers'), 3 levels of fruit bearing (30, 40, 50 tonne / ha) and early or late manual thinning. The aim of the trial was to demonstrate the relative significance of the various measures. The trial at the van Noord orchard was lost due to extremely poor fruit set. The other trials have achieved the set production targets.

### Results of trial at Albers Orchard

Flowering was evaluated on 24 April 2003. The flowering rates varied from 2 to 9.
Some effects.

| **Treatment:** | **Flowering rate 2003** |
|---|---|
| sprayed with lime sulphur | 7.3 |
| not sprayed with lime sulphur | 5.0 |

| **Treatment:** | **Flowering rate 2003** |
|---|---|
| Early manual thinning | 6.1 |
| Late manual thinning | 6.2 |

| **Bearing** | **Flowering rate 2003** |
|---|---|
| 56 fruits per tree | 6.6 |
| 75 fruits per tree | 6.3 |
| 95 fruits per tree | 5.5 |

The good thinning effect of the lime sulphur can thus be seen here, in isolation from further treatment, in a higher flowering rate in 2003. This again emphasises the importance of timely thinning of the tree. The grower made the significant comment that this is still somewhat surprising in view of the disturbed leaf condition of the treated trees in the period directly following three such lime sulphur spray applications. We must report here that preventing superfluous fruiting seems to be even more important for bud formation than maintaining a good leaf condition. Of course, that is not to say that attention to good leaf condition is unimportant.
After the good thinning with lime sulphur, and with the reasonably modest number of fruits per tree, early or

late thinning made no further difference in this trial. The eventual bearing level shows the familiar trend of higher bearing leading to lower flowering rates. Ultimately there was considerable variation in bearing within the treatments. These differences in bearing were clearly reflected in the flowering rates for 2003. The effect applying an accumulation of measures is not reliable in this trial because of the small numbers of trees per object of treatment which meant that the variation in bearing for 2002 begins to exert too much influence.

Results of Ter Linde trial, part 1
Flowering was evaluated on 28 April 2003.

| Treatment: | Flowering rate 2003 |
|---|---|
| sprayed with lime sulphur | 5.6 |
| not sprayed with lime sulphur | 2.8 |

| Treatment: | Flowering rate 2003 |
|---|---|
| Early manual thinning | 5.0 |
| Late manual thinning | 3.4 |

| Bearing | Flowering rate 2003 |
|---|---|
| 75 fruits per tree | 4.9 |
| 100 fruits per tree | 3.8 |
| 125 fruits per tree | 3.8 |

| Pruning treatment | Flowering rate 2003 |
|---|---|
| 1. Standard | 4.1 |
| 2. Remove extra buds | 4.9 |
| 3. Remove extra buds and spare smooth year-old shoots | 3.5 |

The thinning with lime sulphur averaged over all the treatments is now clearly reflected in a much higher flowering rate. A flowering rate of 5.6 is still potentially enough for a full crop: at a rate of 2.8 a full crop would be practically impossible.
The early hand thinning also produced a clear improvement.
The ultimate bearing level appears to be less important. On average the trees at a level of 'only' 30 tonnes/ha did flower a little better.
In the pruning treatments, in fruit counts on 3 June we recorded 17 % fewer fruits in treatment 2 than in treatment 1. Treatment 3 on the other hand had 22 % more fruits than treatment 1. Thus in this treatment in which we had tried to spare smooth shoots to enable bud formation for 2003, this led to more buds per tree and thus also a large number of fruits in the susceptible period following fruit set. These differences now seem to recur in the flowering rates.

In this trial it was possible to clearly show the effect of combining the treatments.
**Without the use of lime sulphur** it was only after extra pruning in accordance with treatment 2 and an early hand thinning to 75 fruits per tree that an average flowering rate of 6.5 could be achieved. All other combinations led to too little blossom in 2003.
**Following use of lime sulphur** and pruning in accordance with treatment 2 the following flowering rates were recorded, averaged over the bearing levels:
- early hand thinning: flowering rate 6.8
- late hand thinning: flowering rate 5.8

Early hand thinning still produces a considerable advantage. Even with late hand thinning the average flow-

ering rate was still sufficient for a normal harvest. Thus it seems possible that a combination of blossom thinning and an adapted pruning can be used to break the cycle of alternative bearing years in Elstar.

### Results, Ter Linde trial, part 2

This trial was set up to replicate the pruning treatments from part 1 on a less vigorous plot. Because it was a less vigorous plot a fourth treatment was added which was a much more extreme version of treatment 3. The trial was laid out in four replications each with 5 trees per field. All the trees were thinned with lime sulphur and then had an additional early hand thinning. The hand thinning did not take into account the fruits per tree but aimed at a reasonably severe thinning to somewhere in the region of 100 fruits per tree. Just before harvest the trees scored an average bearing rate of around 8: thus they bore well but did not quite have a full crop. The trees were rated for bearing prior to harvest in 2002 and for flowering in 2003.

| Pruning treatment | Bearing rate 2002 | Flowering rate 2003 |
|---|---|---|
| 1. Standard | 8.7 | 4.4 |
| 2. Remove extra buds | 8.0 | 4.7 |
| 3. Remove extra buds and spare smooth year-old shoots | 8.2 | 3.6 |
| 4. as 3 but with many shoots cut through + removal of mixed terminal buds. | 7.9 | 5.9 |

These results are very much in line with those of part 1, in which we can see that treatment 2 is an improvement on treatment 1, but treatment 3 is a deterioration. It is interesting to note that treatment 4, a more extreme version of treatment 3, did in fact lead to more blossom in 2003. It seems that the overriding factor is getting rid of a large number of flower buds. The question remains of whether it is worthwhile to spare smooth year-old shoots to make room for flower bud formation the following year. This question cannot be clearly answered by the first trials. A more honest comparison would be to prune trees in different ways to the same number of flower buds and then see whether there are differences in flower bud formation.

## 3.3 Effect of thinning times, fertilisation and bearing

### Experimental design of Ter Linde Orchard trial 2000-2003

In 2000 a multi-year trial was set up at the Ter Linde Orchard to investigate the relationship between different combinations of fruit-bearing levels, fertilisation levels and thinning strategy for level and regularity of production and fruit quality in Elstar (planted in 1992). Can a higher level of fertilisation facilitate higher and more stable production, or permit of a later thinning without sacrificing the increase in production to a poorer fruit quality or increasing pressure from pests and diseases? We are using a combination of 18 treatments in 10 replications, see the 2000 and 2001 annual reports for further background and preliminary results. The last blossom observations were made this spring (see table 3.1, following page).

Once again the trial demonstrated the strong impact of the level of fertilisation. Nitrogen levels in the leaf in August 2002 were on average 2.1 for the low dose treatment and 2.3 for the high dose treatment. A relatively small difference in numbers but a large visual difference in the orchard. With the same thinning regime the high dose treatment scored an average flowering rate of 7.0 while the low dose treatment scored 3.0.

***Table 3.1: Flowering rates in relation to fertilisation level and thinning strategy, Elstar, Ter Linde 2003.***

| Treatment | Fertiliser dose | Thinning June* | Thinning July* | Bloom '03 |
|---|---|---|---|---|
| 10 | High | 150 | 75 | 8.6 |
| 13 | High | 225 | 75 | 8.1 |
| 16 | High | 300 | 75 | 6.3 |
| 11 | High | 150 | 100 | 7.9 |
| 14 | High | 225 | 100 | 7.4 |
| 17 | High | 300 | 100 | 5.4 |
| 12 | High | 150 | 125 | 7.6 |
| 15 | High | 225 | 125 | 6.2 |
| 18 | High | 300 | 125 | 5.6 |
| 1 | Low | 150 | 75 | 4.0 |
| 4 | Low | 225 | 75 | 2.7 |
| 7 | Low | 300 | 75 | 3.0 |
| 2 | Low | 150 | 100 | 4.4 |
| 5 | Low | 225 | 100 | 1.9 |
| 8 | Low | 300 | 100 | 3.4 |
| 3 | Low | 150 | 125 | 3.5 |
| 6 | Low | 225 | 125 | 2.3 |
| 9 | Low | 300 | 125 | 2.1 |

*****no. of fruits per tree thinned 4 and 8 weeks after flowering respectively.
Final bearing levels equivalent to 30, 40, 50 tonnes / ha

The treatment with a thinning level of 300 apples per tree at 4 weeks were excluded from thinning in this round this year so that many trees bore three times this many apples. After 8 weeks these trees were thinned to the final level. Under the prevailing conditions in 2002 this proved to be in time to ensure good bearing for 2003. At all bearing levels we see that the more fruits are left on the tree in the first round of thinning, the more the flowering rate decreases.
With average bearing rates of 5 to 6 there are already a few more trees which do not achieve the desired bearing and which will consequently lower the fruit quality of the lot / batch.

After 4 years of fertilising at a much higher level the trees have really started to grow too fast. The disadvantages in terms of available light and susceptibility to scab are actually not acceptable. Now that this trial has finished the trial block will be managed as a system trial with two treatments in 8 replications. The trial will aim to optimise the benefits of the systems in both the high dose and low dose fertiliser treatments. For the high dose treatment this means root pruning and adapted pruning will be used to try to control the high level of growth. The low dose treatment has been given slight fertilisation since summer 2003 to improve the leaf condition without stimulating growth. The pruning is intended to stimulate vegetative growth in the trees. Both treatments will be thinned to the normal far standard. If possible this will be done regularly and in good time. The results will be monitored for growth and bearing rates.

## 3.4 Nutrient uptake and bearing

In organic growing the nutrient levels in leaves have again been lower than desirable. A seminar with extension workers and researchers discussed the phenomenon that after a heavy bearing year trees sometimes have a poor leaf condition the next year whatever the level of fertilisation. This might be because trees affected by the heavy bearing have too little root growth, and that hampers the uptake of nutrients in the following year. In an organic growing system, in which fewer immediately soluble minerals are applied, root activity is probably more important. Restricting bearing can therefore have a positive effect on the nutritional condition of the trees. The trees in the trial discussed in section §3.3 offer the opportunity to carry out exploratory research into this phenomenon.

***Research question***

What is the effect of the bearing level in 2002 on the uptake of nutrients in 2003 at two different levels of fertilisation?

***Trial set-up***

Six trees were selected from each combination of bearing and fertilisation levels based on their flowering rate in 2003. As far as possible these were arranged into comparable groups of trees. The groups differed only in flowering rates. The trees in treatment 2 will have had a slightly easier time of it in 2003 thanks to their weak flowering. On the other hand these trees also show signs of having suffered under the bearing in 2002. None of the treatments really flowered very heavily.
The trial trees were thinned around five weeks after flowering to around 100 fruits per tree to ensure that all the trees would bear uniformly but not very heavily in 2003.
At the end of June 20 leaves were picked per tree: well-developed leaves from short shoots distributed over the tree. Data were analysed as two different sets: low and high fertilisation level.

***Effect of bearing on nutrient uptake in following year, Elstar, BtL BZ 15,18, 2002-2003.***

| Treatment | Application | Production in 2002 | Flowering rate | Early leaf analysis per tree, 27 June 2003, % of dry matter | | | | |
|---|---|---|---|---|---|---|---|---|
| | | kg / tree (ton / ha) | 2003 | N | P | K | Mg | Ca |
| 1 | Low | 11.5 (28) | 7.3 | 2.00 b | 0.34 a | 1.73 a | 0.25 a | 1.75 a |
| 2 | Low | 16.1 (40) | 3.7 | 1.91 ab | 0.32 a | 1.66 a | 0.23 a | 1.65 a |
| 3 | Low | 20.2 (50) | 5.5 | 1.85 a | 0.31 a | 1.68 a | 0.24 a | 1.67 a |
| 4 | High | 12.3 (30) | 8.0 | 2.28 a | 0.25 a | 1.44 a | 0.31 a | 1.89 a |
| 5 | High | 15.6 (38) | 6.2 | 2.33 a | 0.25 a | 1.50 a | 0.32 a | 1.94 ab |
| 6 | High | 21.4 (53) | 6.0 | 2.26 a | 0.24 a | 1.57 a | 0.31 a | 2.05 b |

**Conclusions**:
At a high fertilisation level the effect of bearing in the previous year is negligible. The effect being researched of trees showing a poor leaf condition the year following heavy bearing thus did not occur this year on this plot for a bearing of up to 50 ton / ha. It may well be that the effect does occur at higher production levels. There is a clear tendency towards higher Ca levels in the leaf. The explanation seems to lie in the difference in flowering vigour and probably fruit bearing in 2003. The young fruits were obviously able to take up a lot of Ca.
At a low fertilisation level there seems to be a trend emerging: the higher the production in 2002, the poorer the uptake of nutrients across the board. This is particularly clear in the case of N. It is striking that we have not seen the familiar inverse uptake of P.

In general then, this trial shows that heavy bearing can influence nutrient uptake in the following year. With good fertilisation and substantial growth as in treatments 4 to 6 this phenomenon does not occur at production levels of up to 50 ton / ha. It may be that it occurs at higher production levels. It should also be noted that in this trial the trees were always thinned to the desired final bearing level no more than 8 weeks after flowering. In trees thinned much later this could of course be worse.

## 3.5 Thinning time and bearing capacity

### Results of trial at Pouw Orchard

In a four-year plot of Elstar the bearing capacity was estimated by the grower to be 8 kg per tree. A trial was laid out with three treatments of 46, 56 and 66 fruits per tree. There were ten trees for each treatment. The trees were thinned manually on 3 June to 15 fruits more than the desired bearing level. This was to leave a small margin for the drop. The fruits were counted again on 24 June and then thinned to the desired level. At that point the grower thought that thinning after flowering could not have any further effect on flower bud formation for the following year. To test this difference of opinion five trees which had not previously been thinned had all the fruits removed on 24 June. All the trees were assessed for growth and bearing in August 2002 and for flowering in spring 2003 (table 3.2).

*Table 3.2: Effect of bearing level on flower development, Elstar, Pouw 2002-2003.*

| | August 2002 | | End of April 2003 | | |
|---|---|---|---|---|---|
| **Treatment** | **Growth rate** | **Bearing rate** | **Flowering rate** | **Distribution** | **% over 5** |
| 1. 46 fruit / tree | 5.2 | 9.1 | 5.8 | 3 - 7 | 80 |
| 2. 56 fruit / tree | 5.4 | 10.3 | 3.3 | 1 - 7 | 30 |
| 3. 66 fruit / tree | 5.0 | 11.5 | 3.4 | 1 - 7 | 40 |
| 4. Fruit-free from 24 June | 7.2 | 0 | 10 | none | 100 |

The development levels were clearly visible in the bearing rates just before the harvest, a score of 10 being optimally full. There was no clear difference in shoot growth, except in those trees which had had all the fruit removed. These had shot into growth. The flowering rates for treatments 1 to 3 were on the thin side. Treatment 1 could clearly be seen to blossom enough but treatments 2 and 3 were clearly on the wrong side of the line. The distribution in flowering rates was broad in all cases. Even more interesting than the average figure is the percentage of the trees that again achieved a minimum bearing rate of 5 and so had a good chance of bearing a full crop in 2003.
The conclusion in terms of bearing capacity is that 8 kg per tree was an overestimate in this case. The question is whether this level would have been achievable if the thinning had been carried out even earlier. This is a possibility, since in general where a tree is thinned to prevent alternate bearing, the earlier it is thinned the better. However in other trials in 2002 thinning at this time was early enough. Another point for consideration for this plot is probably the moderate growth level of these young trees.
The flowering rates of the trees which had all fruit removed on 24 June emphasise once again that thinning even at 8 weeks following flowering can still clearly have an effect on bud formation for the following year, as long as the thinning is severe enough.

### Demo trials with Santana 2002-2003

On 4 farms a demonstration trial was carried out to determine the optimal bearing level for Santana (table 3.3). The impression thusfar is that Santana is not susceptible to bieniallism but a high cropload should not lead to a low fruit quality. The bearing levels were chosen together with the fruitgrowers.

On all farms the leaf quality was not optimal in 2002 due to different reasons, so the potential of Santana may well be better than presented here. Although we see a clear tendency of less bloom after higher croploads, we still had enough bloom in all treatments in 2003. We conclude that Santana is very little susceptible to bienialism and a flowering rate of 5 proved enough for a full crop under the relatively favourable circumstances of 2003. The first three growers have picked to early with resulting suboptimal sugar content. With higher cropload firmness drops and the ratio sugar / acid gets better. A 5 year old plot can carry 15 kg / tree without negative effects on flower formation or fruit quality.

*Table 3.3: Demo-trials with each time 3 levels of bearing of Santana at 4 farms.*

| Crop 2002 | | | Tree 2002 | | | Tree 2003 | | Crop 2002 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| # of Fruits | g fruit- | Production | Leaf- | Bearing- | Vigour- | Flower- | Bearing- | Firmness | | Brix | Acidity | Ca |
| per tree | weight | kg / tree | rate | rate | rate | rate | rate | | | | g / litre | mg / 100g |
| strive-> | 130-200 | ?? | >7 | 10 | 5 | ?? | 10 | >7 | | >12 | 9 a 10 | >5 |
| Warmonderhof, sandy clay, organic, Santana planted 1998; 3000 t / ha, harvested 10th sept. 2002 | | | | | | | | | | | | |
| 58 | 193 | 11,0 | 6,6 | 8,3 | 6,6 | 7,6 | 7,7 | 7,7 | b | 10,8 | 9,9 | 3,4 |
| 74 | 183 | 13,6 | 6,5 | 9,6 | 6,0 | 8,0 | 9,0 | 7,2 | ab | 10,2 | 9,2 | 3,6 |
| 111 | 150 | 16,7 | 6,1 | 11,5 | 4,6 | 8,1 | 7,9 | 6,9 | a | 10,1 | 8,7 | 4,5 |
| Peters, sandy clay, organic, Santana planted 1998; 2250 t / ha, harvested 6th sept. 2002, much weed | | | | | | | | | | | | |
| 75 | 140 | 10,4 | 7,4 | 8,2 | 6,8 | 6,0 | * | 7,5 | a | 10,5 | 9,5 | 5,0 |
| 99 | 137 | 13,4 | 6,9 | 9,6 | 5,7 | 5,6 | * | 7,5 | a | 10,6 | 8,6 | 5,1 |
| 103 | 113 | 11,6 | 6,1 | 11,8 | 4,9 | 5,1 | * | 7,1 | a | 10,5 | 8,3 | 5,1 |
| Olmenhorst, sandy clay, organic, Santana planted 1998; 2700 t / ha, harvested 5th sept. 2002, much weed | | | | | | | | | | | | |
| 76 | 176 | 13,5 | 6,0 | 8,5 | 5,9 | 6,9 | 9,3 | 8,4 | b | 11,0 | 9,9 | 4,8 |
| 103 | 153 | 15,6 | 5,9 | 10,1 | 4,4 | 5,9 | 10,1 | 8,0 | ab | 10,8 | 9,0 | 4,3 |
| 113 | 144 | 15,6 | 5,4 | 12,1 | 3,3 | 4,8 | 9,9 | 7,5 | a | 10,6 | 8,0 | 4,8 |
| v.d.Elzen, sand, organic, Santana planted 1999; 2450 t / ha, harvested 6th sept. 2002, root pruning too strong | | | | | | | | | | | | |
| 83 | 150 | 12,3 | 5,9 | 8,3 | 4,7 | 7,7 | 9,4 | 8,2 | b | 12,7 | 9,4 | 4,5 |
| 104 | 136 | 13,5 | 5,6 | 9,6 | 4,5 | 6,9 | 9,9 | 7,8 | ab | 12,2 | 8,5 | 4,4 |
| 111 | 122 | 13,5 | 4,9 | 11,3 | 3,5 | 5,6 | 9,5 | 7,5 | a | 11,6 | 7,3 | 4,6 |

Of all treatments 10 to 15 trees in random order. Different letters within one farm and within the same column indicate significant differences at 5% level. Leaf rates vary from 1-10 with below 6 as unsatisfactory. Bearing rates vary from 0-15, with 10 as optimum. Vigour rates vary from 0-10 with 5 probably the optimum. Flowering rates vary from 0-10, which corresponds to 0-100% of the buds carrying flowers.

## Demo trials with Collina 2002-2003

Since 2001 a number of Dutch organic growers have begun planting the scab-resistant, early summer variety "Collina". Since this is a new variety there is still much to be learned about its cultivation, and many unanswered questions about growth and fertility. In 2003 various growers established that the growth and flowering of trees planted in 2002 were very irregular: there were remarkably few flower buds. The Resistant Varieties Study Group decided to set up a trial to learn more about the growth, flowering and bearing of Collina. The trial was carried out by LBI, commissioned by DLV under the *BiofruitteeIt* (organic fruit growing) project. DLV will continue with this research in 2004.

At 5 orchards (Paul van der Poel, William Pouw, Harmen Peters, Mart Vandewall and Gerard van Noord) 25 trees were (randomly) marked and for each tree the number of flower clusters (April 2003) and the number of fruits (July 2003) were counted. The results are given in table 3.4 on the next page.

In three of the five orchards growth was disappointing this year. One of the reasons could lie in the ground cover of the tree strip with grass and / or clover. However, at Harmen Peters orchard, the tree strip was not clean cultivated soil either, and growth was still reasonable. Bearing varied widely from orchard to orchard. The reasons for the large differences in fruit set between orchards are still unknown. In a russetting year like 2003 Collina proved susceptible to russeting. At Harmen Peters and Paul van der Poel a single attack of canker was found, both on shoots and trunk. Fruits did not colour as easily in 2003 as in other years.

*Table 3.4: Overview of results Collina trial per grower.*

| Grower | Planted | # Flower clusters April 2003 | Distrib. | Growth rate* July 2003 | Distrib. | #Fruits July 2003 | Distrib. |
|---|---|---|---|---|---|---|---|
| v. Noord | 2001 | * | * | 3,9 | 3-5 | 25 | 3-42 |
| Peters | 2002 | 28 | 2-52 | 5 | 4-6 | 16 | 0-33 |
| V.d. Poel | 2002 | 4 | 0-19 | 5,4 | 5-6 | 6 | 0-26 |
| Pouw | 2002 | 17 | 0-48 | 2,9 | 1-5 | 16 | 0-39 |
| Vandewall | 2001 | 17 | 1-52 | 5,9 | 5-6 | 16 | 2-51 |
| Vandewall | 2002 | 17 | 0-27 | 4,4 | 4-5 | 12 | 0-22 |

* Growth rate of 5 is optimal for the grower: comparison between orchards is not possible

# 4 Canker

## 4.1 Application of calcium hydroxide

LaMi is running a project in Utrecht province in which demonstration trials are being carried out to encourage the use of calcium hydroxide in conventional fruit growing. As advisor the LBI contributed its experience from the projects in previous years.

## 4.2 Registration of calcium hydroxide

Calcium hydroxide has been officially registered with the EU for inclusion in Annex 2B of the Regulation on Organic Production Methods. The LBI, with others, has provided material in support of this application. No decision has yet been taken on the application.

## 4.3 Strategies for canker prevention in organic fruit tree nurseries

Work has continued on the prevention of canker for the organic tree nurseries. The funding body (Product Board for Horticulture) has agreed to an expansion to include a trial on prevention at the stage of clearing of stem shoots of 'knip' trees. The results of this trial will not be available until 2004.
The trial with calcium hydroxide during leaf drop in a year-old cultivation of Topaz was completed this spring (see table 4.1a&b, following page). The trees were subjected to an artificially high infection pressure by hanging up sporulating cankers (mainly conidia).
This trial combined two research questions:

1. the question of dosage, and
2. the question of whether calcium hydroxide works by protecting the leaf scars or by acting directly on the sporulating cankers.

In order to answer the second question the suspended cankers in some treatments were removed during spraying.
Conclusions:

- A higher dose produces a much better effect
- It does not act on the sporulating cankers.

Reduction of the number of cankers by around 50% can be seen as a good result under such severe infection pressure. However, this is not yet sufficient for practice. The question remains of whether an even higher dose or higher frequency could improve on this result.

*Table 4.1a: Doses of calcium hydroxide used*

| Treatment | Dose on cankers | Dose on crop | No. of applications |
|---|---|---|---|
| 1 | - | - | - |
| 2 | 5.0 % | - | 7 |
| 3 | - | 2.5 % | 7 |
| 4 | 2.5 % | 2.5 % | 7 |
| 5 | - | 5.0 % | 7 |
| 6 | 5.0 % | 5.0 % | 7 |

*Table 4.1b: Infection by canker on 3 June 2003.*

| Treatment | % plants affected | *% reduction compared with treatment 1* | Severity of infection |
|---|---|---|---|
| 1. untreated | 79 a | - | 3.7 a |
| 2. cankers 5.0 / crop 0 | 78 a | *1* | 4.0 a |
| 3. cankers 0 / crop 2.5 | 54 b | *32* | 2.4 b |
| 4. cankers 2.5 / crop 2.5 | 51 b | *33* | 2.4 b |
| 5. cankers 0 / crop 5.0 | 41 c | *48* | 1.3 c |
| 6. cankers 5.0 / crop 5.0 | 35 c | *56* | 1.2 c |

Figures followed by different letters: differences significant (á=0.05)

# 5 Fruit rot

## 5.1 Rot resistance test

Infection of a fruit by fungi or disease depends among other things on the resistance of the fruit. The resistance of a product to fungi, pests and diseases is a parameter for the quality of the product. The Louis Bolk Institute is attempting to develop a test for the evaluation of the natural resistance of the fruit, in which the apple can demonstrate how well or poorly a fruit rot fungus (*Botrytis c.)* can spread in the flesh of the fruit. The LBI has previous experience with self-disintegration tests. The problems here were the replicability and the unknown sources of infection.

The question is whether we are in a position to develop a relatively simple but effective method for determining the effect of different growing conditions on the resistance of apple fruits (Elstar, Santana). For this purpose a number of series of apples were infected with *Botrytis c.* and incubated. After some time the diameter or the presence or absence of a patch of rot was recorded. The concentration proved not to affect the size of the patches of rot, but did affect the percentage of rot patches. Further research will be needed to determine whether the method described here offers prospects as an additional parameter for the internal quality of apples.

## 5.2 Prevention of Nectria and Monilia rot

At the Ter Linde Orchard a preliminary trial was conducted on Elstar to see whether Monilia and Nectria can be reduced by sanitary measures. This orchard is known to be relatively badly affected by Monilia. The canker disease pressure in the relevant plot was limited.
For some growers with a lot of fruit rot problems a spraying scheme like those used in conventional growing can seem an attractive option. However, in terms of anticipated efficacy and European legislation the only real option is copper. Copper is not currently permitted for use as a crop protection product in the Netherlands and the organic sector sees the use of copper as having an image problem. However, as a reference for sanitary measures we considered it worth investigating.
The following combinations of measures were tested:

1. untreated
2. copper alone

3. sanitary measures alone
4. sanitary measures + copper

The plots measured around 20 x 20 meters. There were 4 replications. The sanitary measures consisted of removing fruit mummies from the trees before budding and twice removing Nectria cankers.
Copper was sprayed 3 times in the weeks before harvest. Marked trial trees were sprayed with around 1000 l water / ha using a handgun. In each plot around 300 fruits were harvested from six trees. These fruits were stored under ULO conditions and assessed on 12 February. The samples were visually assessed for different types of fruit rot. It was not possible to determine the effect of the different measures on the incidence of individual types of fruit rot. There is however a clear line in the results when all types of rot are viewed together. Both sanitary measures and the spraying of copper seem to reduce the incidence of rot. The total percentage loss however is low and the differences are not statistically significant.

**Losses due to fruit rot, averaged per treatment, Elstar, Ter Linde Orchard, 2003.**

| Treatment | Average percentage rotten fruits |
|---|---|
| 1. untreated | 2.4 a |
| 2. sanitary measures alone | 2.0 a |
| 3. three copper applications | 1.6 a |
| 4. sanitary measures + three copper applications | 1.1 a |

The sanitary measures required around 56 man-hours per hectare: 42 hours for the removal of the mummies and 14 for an extra round of canker pruning. Picking the mummies took a relatively long time because there were already some leaves on the trees. The canker pruning took very little time: however, at a higher infection pressure it would be more likely to be 40 hours / ha.

Three applications each of 300 g / ha copper oxychloride increased the copper content of the whole fruit from 0.57 to 0.68 mg per kg fresh product. These levels are well within the maximum value of 20 mg Cu / kg fresh product and also within the stringent standard for baby food of 1 mg / kg fresh product.

## 5.3 Prevention of fruit rot by immersion of fruits prior to storage

We have had conflicting experiences with the use of Calcium chloride in immersion tanks to prevent fruit rot during storage. In an earlier trial we were unable to achieve any positive results (see 2002 annual report). This year we conducted another storage trial in which fruits were immersed. As well as investigating the calcium chloride (3%) again, we wanted to gain experience with a new citrus pip preparation which is reported to have worked well against fungi. Ultimately the preparation proved to be heavily contaminated with a synthetic preservative. The results of the storage tests are thus not elaborated for this treatment.

For this trial Elstar fruits were picked in dry conditions into storage bins and transferred in the barn into plastic crates of 15 kg capacity. The crates were then randomly allocated to the different treatments. The fruits were immersed by hand and after draining returned to the crates. The crates were stacked on pallets and then stored in a commercial coldstore. Around 1200 fruits per treatment were stored under ULO conditions and assessed on 12 February.

The total loss due to fruit rot was around 5 %. There was no reliable difference between the treatments: untreated, immersed in water and immersed in 3% calcium chloride.

# 6 Fruit quality

Fruit quality is an increasingly important aspect of fruit production. The supermarkets in particular continually raise the standards required for (external) product quality. Using organic growing methods it may not always be possible to meet the high standards for external quality. This means that the internal quality will become increasingly important. LBI is currently running 2 projects on apple quality: “Classy Apples in the Chain” (2001-2004) which involves monitoring and working with partners in the chain to reduce the quality gap be-

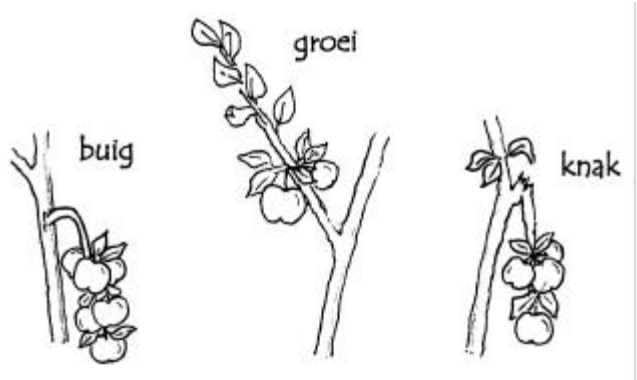
tween supply and demand and also reduce the distance between the start and end of the chain. The second project, "Parameters for Fruit Quality" (2001-2003) addresses more fundamental issues about suitable quality parameters for organic production. (See also 2002 report).

## 6.1 Monitoring cultivation of Elstar and Santana

The last round of monitoring took place in 2003. Only Santana was still being sampled at 4 orchards. The results of the monitoring were comparable to 2002. However there was one visual effect of the year: the dryness of the season meant there was no scab, flyspeck or sooty blotch to be found on the fruit. Russeting again posed considerable problems for a number of orchards. The results will be published in the course of 2004 in the final report on the "Classy Apples" project.

## 6.2 Vigour control and fruit quality in Santana

In practice twigs are sometimes snapped rather than bent (figure 1) due to labour-saving measures. Snapping saves labour but the down side is the loss of a part of the branches and poorer fruit quality. As a result of the break, the plant struggles for water and assimilates and a type of 'emergency ripening' takes place in the first season after snapping.




(illustration above: buig = bent; groei = growing; knak = snapped)
Figure 1: Bent, growing and snapped branches (drawing by M. Zanen)

**Difference in fruit quality due to different growth management methods in Santana**

| Harrie vd Elzen, 2001 | size mm | target value | firmness | Brix | acidity mg/l | calcium mg/100vg |
|---|---|---|---|---|---|---|
| 1. upward growing shoot (calcium competition) | 81 | 0.41 | 6.9 | 12.4 | 10.2 | 4.6 |
| 2. shoot bent down (normal ripening) | 79 | 0.38 | 6.7 | 12.5 | 10.2 | 6.4 |
| 3. twig snapped down ('emergency' ripening) | 69 | 0.21 | 6.4 | 12.4 | 9.8 | 6.1 |

## 6.3 Calcium levels following application of calcium hydroxide

Within the framework of the "Classy Apples" project apple samples were collected from two conventional orchards from the LaMi-project referred to in section 2.1. to investigate whether the application of calcium hydroxide to control canker leads to higher calcium levels in the fruits the next year. The hypothesis is that calcium can be taken up through the trunk and that the resulting higher calcium reserves lead to higher levels in the fruits. Fruits of Jonagold were sampled on 18 June. At each orchard a comparison in two replications was made between untreated plots and those sprinkled with calcium (see table 6.1, following page). A total of around 400 kg calcium hydroxide was applied per hectare at both orchards. In a modest trial like this one it was not possible to demonstrate a reliable difference between the treatments. We cannot exclude the possibility that calcium levels may be increased in this way but it is unlikely that this will prove to be a significant contribution to the calcium supply.

*Table 6.1: Results of early fruit analysis (18 June 2003) in Jonagold at 2 orchards.*

| Grower | Cal-cium | Replica-tion | N (% dm) | P (% dm) | Ca (% dm) | K (% dm) | Mg (% dm) | dm (%) | mg Ca / 100g fresh |
|---|---|---|---|---|---|---|---|---|---|
| grower 1 | yes | 1 | 1.03 | 0.12 | 0.067 | 1.23 | 0.07 | 14.2 | 9.5 |
| | yes | 2 | 0.92 | 0.11 | 0.075 | 1.13 | 0.06 | 14.2 | 10.7 |
| | no | 1 | 0.88 | 0.06 | 0.067 | 1.20 | 0.06 | 14.2 | 9.5 |
| | no | 2 | 0.99 | 0.12 | 0.064 | 1.27 | 0.07 | 14.2 | 9.1 |
| grower 2 | yes | 1 | 0.83 | 0.09 | 0.087 | 0.97 | 0.06 | 14.1 | 12.3 |
| | yes | 2 | 0.83 | 0.10 | 0.084 | 1.03 | 0.06 | 13.8 | 11.6 |
| | no | 1 | 0.90 | 0.11 | 0.080 | 1.12 | 0.06 | 13.6 | 10.9 |
| | no | 2 | 0.82 | 0.09 | 0.080 | 0.97 | 0.06 | 14.3 | 11.4 |
| Total | calcium | | 0.90 a | 0.11 a | 0.078 a | 1.09 a | 0.06 a | 14.08 a | 11.0 a |
| | untreated | | 0.90 a | 0.10 a | 0.073 a | 1.14 a | 0.06 a | 14.08 a | 10.2 a |

Figures in the same column followed by the same letter do not differ significantly with a certainty of 95%

## 6.4 Search for relevant parameters for 'vitality'

### International association for 'Organic Food, Quality and Health' (FQH)

The purpose of the group of researchers and traders brought together under the FQH banner is to develop a new concept of quality based on life processes and to select and further develop relevant methods of measurement. The results of the research must help growers to produce products of great 'vital quality' and help consumers to recognise such products. The first part of the research was carried out on apples in 2000-2001; and subsequently on carrots, while a second project is underway on apples in 2001/2003. For further information on the 'vital quality' concept see the previous annual report and associated publications (FQH-01, LF63).

### The impact of fertilisation and biodynamic preparations on the quality of Elstar, 2001-2003

At the Ter Linde Orchard 24 batches each of 150 Elstar apples were grown especially for this project. For two growing seasons strictly identical thinning was carried out, and variation was introduced into the level of fertilisation with fast-acting fertiliser (chicken manure pellets and Maltaflor: 0, 40, 80, 120, 160 kg N/ha/year), composted biodynamic cow manure (100 kg N/ha/year), in 2 replications with and 2 replications without biodynamic preparations. A large amount of data was collected on the soil, phyllotaxis, growth, pests and diseases, etc. Various quality aspects of all these apple samples were measured by various laboratories in the Netherlands and abroad. Both the usual quality characteristics and experimental, more holistic characteristics were determined: size, colour, firmness, flavour, mineral contents, biophotons, electrochemical characteristics, copper crystallisation pictures, capillary dynamolyses, etc. The data will be published in the FQH report in 2004.

### Inner quality concept for apples

The international association for 'Organic Food, Quality and Health' (FQH) was set up to promote research into the health effects of high-quality organic food. For this purpose a coherent concept of quality is required which fits in with the wishes of organic agriculture, but concrete research methods are also needed to measure quality and health effects. In this context the Louis Bolk Institute carried out research in 2000 using apples as an experimental crop at the Ter Linde Orchard (publication 2001). Apples were chosen because much is already known about apple quality and how it relates to cultivation measures. This familiar knowledge is used to provide a scientific foundation for the concept and to verify less familiar measuring methods.
In 2001-2003 a follow-up project was carried out, also at the Ter Linde Orchard. For this small trial plots were set out for three years in 4 replications and treated with different quantities and types of fertiliser (for results see the piece in §2.2) and over and above that there were 4 large blocks, 2 with and 2 without biodynamic preparations. Due to differences in the soil and uncertainty as to whether one of the unsprayed blocks really remained untreated, we did not really succeed in investigating the effect of Biodynamic sprays.

The quality concept was originally referred to as 'vital quality' (see publ. LF63), but in view of the many different interpretations of the term 'vital' the more neutral term 'Inner Quality Concept' has now been adopted. The nice thing about the concept is that it ties in with the way an organic grower works: he or she looks after the life processes in the crop or animal. All life processes are growth processes and can occur in different proportions and in mutual cooperation (level of integration).
By giving the life processes a central place, it was possible to make a link between how the consumers view the quality of the product in the shop, how growers regard their crop and what growers correct during cultivation to improve the quality. Consumers do not have uniform desires; their choices in food depend on individual preference, state of health and mood. There is a market for different good inner qualities, such as a long-keeping, mildly acidic crisp apples (more emphasis on growth processes) in addition to softer, sweeter more aromatic apples (more emphasis on differentiation processes). The concept shows how such accents in the end product are linked to accents in the cultivation. Apple growers thus do not glean very much new information from this research, but it makes growers of other products aware of these relationships.

Many different methods of measuring apple quality were assessed for the extent to which they say anything about growth, differentiation or integration processes during cultivation. Among the less familiar methods the copper crystallisations (LBI) and the spectral luminescence (biophoton method with separate colours by Kwalis in Germany) came to the fore as having good prospects for this quality approach. These two labs were able to recognise from the apple the extent of growth and differentiation during cultivation. The electrochemical methods and the biophotons with white light (by Meluna) showed too much opaque variation, so we will not pursue these 2 methods.
We found a clear link between nitrogen levels in leaf analyses in 2002 and in the flower bud analyses in 2003. However it was striking that there was little relationship between nitrogen in the flower bud and percentage of bloom and fruit set in 2003. The chromatograms of the soil with compost were evaluated (blind) by the Ecosys lab as having more soil life than soil with commercial fertilisers. The same applied to the soil samples at the Soil Foodweb lab.

The full report will be published in spring 2004. See also the summary in English, German and Dutch at www.louisbolk.nl or LBI publication FQH-04.

# 7 Sales

## 7.1 Shop monitor

For two years, in the Classy Apples project, the apple quality of 2 varieties (Elstar and Santana) was monitored at the time of harvest at many different organic orchards, after a standard period of storage and after a standard period on display. This was linked to a consciousness-raising campaign to use every opportunity to optimise the quality in the cultivation and storage stages.
Because much quality is lost in the wholesale and retail parts of the chain, we started in 2003 to record the quality experienced by the consumer in the shop: the 'shop monitor'. Following on from the Classy Apples project we call this "Classy Apples in the chain".
The aim is to build up a picture of the presentation, price, external and internal quality of apples as experienced by the consumer at various points of sale, delivered from various batches at different times of year. At the same time we are talking to participants in this project about the results and trying to address points for improvement together. This project can provide building blocks for a future quality management system.
The results of this project will be published in the course of 2004.

## 7.2 Chain discussions

We have in the past year again held discussions with the chain within the framework of the Classy Apples project. The most frequent and the most useful in substance were the discussions with the chain Biofruit – Vogelaar-Vredehof – Albert Heijn. The chain discussions surrounding Odin were terminated because the agreements made could not always be honoured. Good organisation on the part of the growers concerned seems to be essential to the functioning of chains, together with the will to properly address the points for

improvement together. Since Wouter van Teeffelen was appointed as chain manager for Prisma / AgroEco we have left these discussion more and more to him.

## 7.3 BioFach

The annual Biofach fair was held from 13 to 16 February 2003 in Nuremberg, Germany. Organic producers from all over the world exhibited their wares. At this fair with around 2000 stands there were also many producers, cooperatives and traders in organic fruit. The Dutch growers' association Prisma had a stand for the first time this year.
The Louis Bolk Institute in collaboration with Wouter van Teeffelen of AgroEco organised an excursion to Biofach for interested Dutch growers. In addition to a visit to the trade fair, an evening meeting was arranged with representatives of marketing organisations for organic fruit from the Netherlands, Austria, Southern Tyrol (Italy) and the Lake Constance area and Das Alte Land in Germany. These activities were part of the Classy Apples project which aims to reduce the gap between the desired and delivered quality of organic apples. The aim of the trip to Biofach was to give growers more insight into the world-wide supply of organic apples and the way the trade in this product is conducted.
For many growers still looking for their niche in the market this was a good opportunity to gain a broad view of the options. For the established grower-traders it was the perfect chance to strengthen existing contacts and make new ones.
The experiences of the participants are reported in publication LFR74.

# 8 The future of organic fruit growing

The expansion of organic agriculture has resulted in interest from growers and traders who entered the organic field for economic reasons. These entrepreneurs bring with them a high level of specialisation and expertise and their concerns are different from those of their more idealistic, all-round predecessors: cost price reduction, more security in cultivation, strict monitoring of standards, etc.
We should guard against this one-sided emphasis on cost price reduction making organic fruit growing identical to its conventional counterpart. Thought must be given to the entire cultivation system, the selection of varieties, organic origin of the parent material, use of control agents, marketing strategies and advisory services, and we need to reconsider motivation and standards and how we deal with risks, variety ownership and land ownership.

## 8.1 Marketing strategies

In 2003-2004 in collaboration with the socio-economic section of the Louis Bolk Institute and the University of Nijenrode we described the various marketing styles (or trading circles). The object is to provide an inspirational image to encourage traders and fruit growers to consciously opt for a certain trading style and then consistently develop it in profiling and communication about apple quality. 'Consistency' is important because the current mixture of styles sometimes fails to do full justice to any one aspect. Market differentiation is important because it makes it possible to involve more consumers and more products, thus allowing for more expansion than if all attention were devoted to a single type of marketing. A report on this research will be published in Dutch in early 2004.

# 9 Exchange of knowledge

## 9.1 In the Netherlands

We organised seminars on fruit quality for Prisma, the organic fruit growers' cooperative, in January and April. PieterJans, Joke and Marleen of the LBI act as advisors to Prisma. We presented LBI research findings on excursions and open days.

## 9.2 International exchange

We did not attend any international conferences this year. We did of course maintain bilateral contacts with foreign colleagues.

## 9.3 International Working Group on Biodynamic Fruit Growing

This group was set up in 2001 to promote the exchange and development of specific biodynamic aspects in fruit cultivation (secretariat in Dornach). Piet Korstanje and Joke Bloksma represent the Netherlands in this group, and try to make the work of the group more relevant to practice. The research group made a working visit to Germany in July 2003.

## 9.4 Working group on organic fruit growing

The objective of the working group is to identify problems in the development of organic fruit growing and if possible develop initiatives to solve them. The working group has the status of a programme advisory committee for research on organic fruit growing and is much consulted for advice on priorities and problems. The working group met five times in 2003.

At the end of 2003 the group consists of: Harald Oltheten (chair since mid-2003, organic small fruit grower, Prisma research coordinator), Robin Kars (organic fruit grower, PC (Apple and Pear Product Commission), chair until mid-2003), Hans Poley (organic fruit grower), Louis Ruissen (organic fruit grower, LNV-advisory group), Rein Mantel (organic fruit grower), Francesco Melita (*Biologica*), Joke Bloksma (LBI, secretary), Rien van der Maas (PPO), Gerard v. Noord (organic fruit grower), Gerjan Brouwer (agricultural advisory expert with *DLV Adviesgroep NV*), Marc Trapman (agricultural advisory expert with *Biofruit advies*), Eric Regouin (LNV expertise centre) and Wouter van Teeffelen (organic fruit growers chain manager).
The work of this working group received financial support in 2003 from PT and Platform Biologica (1800,- euro) and Louis Bolk Institute (1200,- euro), which is spent on an attendance fee for growers, room hire and the work of the secretariat.

## 9.5 Publications

### Fruit growing research binder

In 2003 we started binder 6 and 3 new titles were published in the fruit growing series. The policy of including both research results and lectures in the publications remains unchanged. Members of the Prisma cooperative automatically receive copies of the publications.

### Other publications in 2003

20 January 2004 saw the launch at the Louis Bolk Institute of the new handbook "*Biologische appels en peren - teeltmaatregelen voor kwaliteitsfruit*-" (Organic apples and pears – cultivation measures for quality fruit). Bert van Ruitenbeek, director of *Biologica*, was presented with the first copy by Joke Bloksma (ed.). The book is the culmination of years of collaboration between fruit growers, researchers and consultants. The handbook was written by experienced fruit growers, their advisors and researchers interested in a coherent vision of stable and environmentally friendly production methods for apples and pears.

The following articles appeared in specialist literature:

- Zanen. M. *Nieuwe resistente rassen in smaaktoets vergeleken* (New resistant varieties compared in taste tests), 2003. Fruitteelt 47, p.10-11.
- Jansonius, P.J. *Vruchtboomkanker te lijf met gebluste kalk* (Attacking canker with calcium hydroxide), 2003 De Boomkwekerij 49, p. 12-13.

### Website www.louisbolk.nl -> fruitteelt

In 2003 we posted much of our past and present data on the website of the Louis Bolk Institute. Our policy is to make all our own publications and lectures available in Dutch and English free of charge via the website.

# 10 Plans for 2004

Next year will see the completion of the Classy Apples in the Chain project. A great deal of effort will go into plans for a follow-up to this project.
In addition there are a still several smaller projects running on canker in tree nurseries and orchards. A number of long-term experiments relating to regulation and fertilisation are being maintained with the aid of the Ter Linde Orchard as we are expecting to be able to glean further information from them in future projects.

## 10.1 LBI publications on fruit growing

| | | |
|---|---|---|
| LO3 | Alle nog beschikbare publicaties als totaalpakket map 1 t/m 6 (1990-2002) excl. porto<br>*all available publications from binders 1 to 6 (1990-2003) excl. p&p* | € 100.00 |
| | Alle publicaties van map 5 (1999-2002) excl. porto; *all publications in binder 5 (1999-2002) excl. p&p* | € 35.00 |
| LO4 | Abonnement lopende jaargang incl. porto; *current year subscription incl. p&p* | € 35.00 |
| | Collective subscription, Prisma members | € 32,50 |
| | *If the title is repeated in a foreign language in between brackets, you will find a summary in that language*<br>*Titels with "w" behind the price can also be downloaded from www.louisbolk.nl* | ↓excl.porto |
| | 1990, volume 2, binder 1: | |
| LF2 | Bloksma, J., 1990: De **bewaarkwaliteit van appels**; verslag van een vergelijkend onderzoek naar de bewaarkwaliteit van biologisch geteelde Rode Boskoop op 8 verschillende bedrijven in 1989 *(Lagerqualität von biologisch gezüchteten 'Roter Boskop'-Aepfeln bei 8 verschiedenen Betreiben in 1989; Preservation quality of organic grown 'Red Boskoop' apples of 8 different orchards in 1989)*. LBI (46p) | € 3.59 |
| LF6 | Bloksma, J., 1990: **Kaliumprofiel** bij 5 verschillende fruittelers, LBI (4p) | € 1.14 |
| LF9 | Bloksma, J. en M. van Brakel, 1990: De **zelfontbindingstest** als mogelijke kwaliteitsbepaling bij appelen. *(Der selbstzerstörungstest bei Aepfel; the selfdecompositiontest of apples).* LBI (12p) | € 3.40 |
| LV7 | Baars, T., 1990: Het **bosecosysteem** als beeld voor het bedrijfsorganisme in de biologisch dynamische landbouw, LBI & Ver. v.BD-landbouw. (32p) | € 5.68 |
| | 1991, volume 3, binder 2: | |
| LF12 | Bloksma, J. en M. Vandewall, 1991: **Morellen**, tak-en bloesemsterfte bij zure kers – 3 (5p) | € 1.14 |
| LF13 | Bloksma, J. en T. Wijnen, 1991: Minimaliseren van **zwavelbespuitingen**, LBI (4p) | € 1.14 |
| LF14 | Wijnen, T. en J. Bloksma, 1991: **Minerale en plantaardige olie tegen groene appelwants en bladluizen**, LBI (5p) | € 1.14 |
| LF15 | Wijnen, T. en J. Bloksma, 1991: De invloed van **oorwormen op de luizenaantasting** in appelbomen. *(The effect of earwigs on aphid in appletrees. Observations in the orchard of Korstanje in Holland 1986-1991.).* LBI (30p) | € 4.54 |
| LF16 | Bloksma, J. en H. van Noort, 1991: **Valeriaan-preparaat** ter stimulering van nieuwe bloemknopvorming na nachtvorstschade bij aardbeien, tussentijds verslag, LBI (4p) | € 1.14 |
| LF17 | Bloksma, J., 1991: **Aantekeningen over luizen** *(Remarks on Aphid on apple and plum; Aufzeichungen über Blattläusebefall von Apfel- und Plaumenbäumen).* LBI (56p) | € 6.80 |
| LF18 | Bloksma, J., 1991: **Jaarverslag 1991** onderzoek fruitteelt LBI met plannen voor 1992, LBI (16p) | € 3.40 |
| | 1992, volume 4, binder 2: | |
| LF19 | Bloksma, J. en G. Brouwer, 1992: **Studiereis** biologische Fruitteelt; Venlo-Keulen-Herford-Das Alte Land, 31 juli tot en met 2 augustus 1992. (28p) | € 6.80 |
| LF20 | Wijnen, T. en J. Bloksma, 1992: Waarnemingen van de **vroege fruitmot** *(Pammene rhediella*) en | € 3.40 |

bestrijding door Bacillus thuringiensis en Neem-extrakt. *(Observations of the fruitlet mining tortrix moth and control by Bacillus thuringiensis and Neem-extract).* LBI (14p)

LF21 Wijnen, T. en J. Bloksma, 1992: Het voorkomen van **oorwormvervuiling** van appels door aanbieden van schuilplaatsen. *(Less earwig excrements by hanging up hiding-place sacks; Weniger Ohrwurmverschmutzung durch Aufhängen von Schlupfsäckchen).* LBI (4p) € 2.26

LF22 Bloksma, J., 1992: Telling van **schurftconidiosporen** tussen de knopschubben bij biologische fruitbedrijven. LBI (4p) € 2.26

LF24 Bloksma, J., 1992: **Jaarverslag 1992** Fruitteeltonderzoek LBI (18p) € 3.40

1993, volume 5, binder 2:

LF25 Bloksma, J., 1993: **Zwavel als schurftbestrijdingsmiddel**. *(Evaluation of the use of sulfur for scab control in organic fruit production).* LBI (70p) € 6.80

LF27 Bloksma, J., 1993: Evaluatie van 4 behandelingen van uitgesneden **kankerwonden** bij appelbomen. *(Vergleich von 4 Behandlungen von Wunden an Apfelbäumen nach dem Ausschneiden des Obstbaumkrebses, Nectria galligena).* LBI (8p) € 2.26

LF28 Wijnen, T. en J. Bloksma, 1993: Bestrijding van **vruchtbladroller** met Bacillus thuringiensis. *(Bekämpfung des Apfelschalenwicklers Adoxophyes orana mit Bacillus thuringiensis; Management of summer fruit tortrix moth Adoxophyes orana with Bacillus thuringiensis).* LBI (8p) € 2.26

LF30 Bloksma, J., 1993: **Jaarverslag 1993** Fruitteeltonderzoek LBI (15p) € 3.40

1994, volume 6, binder 3:

LF31 Wijnen, T., J. Bloksma, G. Brouwer en Q. Lawant, 1994: Bestrijding van de **appelzaagwesp** met het plantaardige middel Quassia *(Management of the applesawfly, Hoplocampa testudinea with the plantextract Quassia*) *(Bekämpfung der Aepfelsägewespe mit dem Plfanzlichen Präparat Quassia).* LBI (40p) € 6.80

LF32 Bloksma, J. 1994: **Bedrijfsportret** van het Bd-fruitbedrijf van Piet en Heleen **Korstanje**. LBI (70p) € 6.80

LF34 Bloksma, J. 1994: **Bodemveranderingen na omschakeling** van gangbare naar biologische fruitteelt en het effekt van verschillende compostsoorten en verschillende toepassingstijdstippen. *(Veränderungen im Boden nach Umstellung von Konventionellem auf biologischen Obstbau und dem Effekt verschiedener Kompostarten und verschiedener Anwendungzeitpunkte)*. LBI (25p) € 4.54

LF35 Bloksma, J. 1994: **Jaarverslag 1994** Fruitteeltonderzoek LBI *(Annual report research organic fruitgrowing).* LBI (13p) € 3.40

1995, volume 7, binder 3:

LF37 Bloksma, J., 1995: **Biologische fruitteelt in Noord-Amerika**, reisverslag 1995 *(Organic and biodynamic fruitgrowing in the North of America, report of a journey in 1995)*. LBI (48p) € 6.80

LF38 Bloksma J., 1995: **Jaarverslag 1995** Fruitteeltonderzoek LBI. *(Annual report research organic fruitgrowing).* LBI (24p) € 3.40

1996, volume 8, binder 3:

LF39 Bloksma, J., 1996: **Mogelijkheden voor de bodemverzorging in de fruitteelt vanuit biologische gezichtspunten.** Literatuur-overzicht. A4-formaat LBI (155p) € 11.34

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