



Midterm Status Report 2003 and Application for Continuation in 2004

For research projects financed by grants from
The Directorate for Food, Fisheries and Agro Business
under the Danish Ministry of Food, Agriculture and Fisheries

1. Research program

Research in organic farming 2000-2005 (DARCOF II)

2. Project title and number

I.2 Development of sustainable production systems for apples.
FØJO II.

3. Head of project

Seniorscientist, Hanne Lindhard Pedersen.
Danish Institute of Agricultural Sciences
Department of Horticulture
Postboks 102
Kirstinebjergvej 10,
DK 5792 Årslev
Phone: 0045-63904343
Fax: 0045-63904396
E-mail: Hanne.Lindhard@agrsci.dk

4. Participating institutes

Danish Institute of Agricultural Sciences
Department of Horticulture
Postboks 102
Kirstinebjergvej 10,
DK 5792 Årslev
Phone: 0045-63904343
Fax: 0045-63904396

5. Other project staff

Seniorscientist Marianne Bertelsen,
Danish Institute of Agricultural Sciences
Department of Horticulture
Postboks 102
Kirstinebjergvej 10,
DK 5792 Årslev
Phone: 0045-63904343
Fax: 0045-63904396

6. Project period (month, year)

Start of project: September 2000
End of project: December 2004

7. Midterm description of the project, its results and progress, and application for continuation in 2004

A. Project summary

Organic growers estimated a yield reduction of at least 86 percent compared to conventional production in a questionnaire. The organic growers only expects 14 percent of a conventional yield. The estimation was based on production of the most common conventional grown varieties. The main reason for this low productivity is lack of control measurements against diseases and pests, especially apple scab (*Venturia inaequalis*). In Denmark most organic pesticides are not registered. Copper, for example, has not been on the market for 7 years.

The challenge is to find methods to increase the yield and fruit quality in an unsprayed organic apple orchard.

WP 1.: Reducing apple scab infection risk using cultural methods.

The cover crop trials ended after the season 2001, but the results is a part of this application and the trees still are used for other trials in Darcof project no. VII.5:

Control of scab in organic apple growing (Stop Scab).

The conclusion from the cover crop trial were:

'In an unsprayed organic apple orchard the best fruit quality based on fruit colour and the lack of pest and disease damage was obtained in trees grown in an alley way system which gave a nitrogen supply in the lower end of the optimum range.

The varieties: 'Florina', 'Vanda', 'Retina' and 'Redfree' was less infected by apple scab. The resistance to apple scab was broken down in most varieties'.

The results from this research caused an invitation to participate in the EU-application: REPCO: Replacement of cobber fungicides in organic production of ap-

ple and grapevine in Europe. At this stage we are almost 100 percent sure that we are a part of the project. We are invited to the 'kick off' meeting 1 December 2003.

Cultural techniques 1 and 2.

As the cover crop trial showed an increasing infection of diseases with an increasing nitrogen level and a tendency to a lower yield with lower nitrogen the goal is to find the optimum level of nitrogen in the soil and plants in relation to the disease infection.

To investigate this, two new trials were planted in April 2001. Since the aim is to investigate the apple scab infection in relation to soil treatment the non-resistant varieties 'Discovery' and 'Ingrid Marie' was chosen. They can be infected by apple scab, but are recommended for organic production because they are less susceptible. The trees have been well established in very dense planting systems. In spring 2002 6 fertiliser treatments were established in the two varieties.

In the variety 'Discovery' all soil treatments are replicated 3 times and combined with 4 rootstocks and three planting densities. Each plot comprises 4 trees, in total 874 trees have been planted. Rootstocks: M9, B9 (early terminal bud development), M26 and MM106 (Late terminal bud development). Planting distances: 0.6m, 0.9 m and 1.2 meter.

In the variety 'Ingrid Marie' all soil treatments are replicated 4 times and combined with 4 rootstocks and three planting densities. Four trees constitute a plot, and in total 1120 tree have been planted. Rootstocks: M9, B9 (early terminal bud development), M26 and MM106 (Late terminal bud development). Planting distances: 0.6m, 0.9 m and 1.2 meter.

The trails are now fully established. The trees grew well in 2002 and 2003. We expected a small yield in 2002, but as 2002 was a warm summer with many insects infestation we lost most of the crop to apple saw flies. In 2003 we still had many apple sawflies flying during flowering and we decided to spray with quassia to be sure that we would get some yield. We sprayed twice, but still the crop was reduced compared to an optimal yield. Quassia is allowed for organic fruit production in the European guidelines.

Data collected:

Trunk diameter was collected just before establishment of the treatments and then after growth 2002. Infections of fruit tree canker and apple scab on leaves were evaluated late season 2002 and 2003. Leaf samples were taken in every plot in 2002 and 2003. Soil samples (N-min) to investigate the nitrogen content and supply were taken in April, June and September 2003. Percentage of water in the upper 50 cm of the soil surface to show the water use of cover crop and the tree supply were taken weekly in the growing period 2003. Visual control of pests and predators was carried out after flowering to see the effect of cover crops and the insect's populations.

The fruits were harvested in August and September 2003. Yield, fruit size and outer fruit quality will be recorded autumn 2003 after cool storage.

Inner fruit quality of the variety Ingrid Marie on rootstock M9 with focus on effect of soil treatments and the planting distance was carried out late September in the laboratory. The following analyses were done: Mineral analyses, fruit firmness, sugar, starch, colour and fruit weight.

Unfortunately the yield was low in 2003 due to infestation of apple sawflies. Therefore we were not able to do special research in optimal picking date. The inner fruit quality of Discovery cannot be carried out due to the very low yield.

This trial includes many of the very actual questions in organic apple research in Europe. Therefore we are now a part of the big EU-project "Qualitylowinputfood", where contract negotiations are running in this very moment.

European Study trip.

To be updated in current research activities on organic fruit production, Hanne Lindhard Pedersen visited relevant institutions through Europe during the summer 2003. Focus was on fruit quality and methods used to determine organic quality.

A report is written in Danish.

Table A.1: Work package list (from application)

| No. | Work package title | Participants* | Budget (1.000 DKK) | Start | End | Deliverable no(s): |
|-----|--|--|-----------------------|-------|------|---|
| 1 | Reducing apple scab infection risk using cultural methods. | <u>Hanne Lindhard Pedersen</u> Marianne Bertelsen | 1.350 | 2000 | 2004 | D1, D2, D3, D4, D5, D6, D7, D8, D9. |

Responsible participants are underlined

B. Objectives and expected achievements

The overall objective is to reduce the infection risk of apple scab in organic apple orchards using culture techniques.

The expected achievement is to increase the Danish production of high quality organic apples.

The principal objectives are:

1. To find the best combination of nitrogen supply, use of rootstocks and planting distance to prevent apple scab infections and improved productivity.

WP 1: Reducing apple scab infection risk using cultural methods.

Expected achievement:

The effect of cover crops on nitrogen supply and infections of fungal diseases will be investigated.

The organic apple production is optimised by investigating the effect of cultural methods on tree growth and susceptibility of apple scab. During the project period annual field days will be carried out. Results will be published in relevant agricultural magazines.

Project summary (from application)

For several fruit crops, organic production is extremely difficult because of the high quality demands of the product. In Denmark, only about 5% of the fruit production area are grown organically, and there has been a slight decrease during the last 5 years. The

reason for the decrease in the apple area is that the control of apple scab (*Venturia inaequalis*) has been very difficult the last 5 years.

The use of cultural methods to reduce the apple scab infection is stressed in Denmark where the use of organic pesticides is limited compared to other countries in the world.

The overall objective in this project is to reduce the infection risk of apple scab in organic apple orchards using culture techniques. The expected achievement is to increase the Danish production of high quality organic apples.

The objective is to find the best combination of nitrogen supply, use of rootstocks and planting distance to prevent apple scab infections and improve productivity.

C. Midterm results and progress

C.1 Description (summary) of main results and conclusions

Organic growers estimated a yield reduction of at least 86 percent compared to conventional production in a questionnaire. The organic growers only expects 14 percent of a conventional yield. The estimation was based on production of the most common conventional grown varieties. The main reason for this low productivity is lack of control measurements against diseases and pests, especially apple scab (*Venturia inaequalis*). In Denmark most organic pesticides are not registered. Copper, for example, has not been on the market for 7 years.

The challenge is to find methods to increase the yield and fruit quality in an unsprayed organic apple orchard.

WP 1.: Reducing apple scab infection risk using cultural methods.

The following trial ended after the season 2001, but as it is a part of this application and the trees still are used for other trials in Darcof project no. VII.5: Control of scab in organic apple growing (Stop Scab), the results are described here.

Cover crop:

The following cover crops are established in 1994:

1. A permanent grass mixture of *Festuca rubra* and *Poa pratensis*.
2. Clover grass mixture of *Trifolium repens* and *Lolium perenne*.
3. Annual cover crop of *Lolium multiflorum* and *Trifolium resupinatum*, sown every year in July. The soil has been kept black from April to July.

Fruits produced on trees managed with a grass alleyway and thereby a lower nitrogen supply to the trees obtained the best coloration. A lower nitrogen supply, especially during fruit development results in more red fruits. 15 tons fruits from the grass cover crop had more than 75 percent red surface as average for 1999 - 2001; whereas only 8-9 tons fruits grown in the clover grass or the annual cover crop had more than 75 percent red surface.

The apple scab infection was more numerous on apples grown in the annual cover crop, which gave the largest supply of nitrogen to the trees. This was the case although the level of total nitrogen in the leaves was within the optimum level for fruit production.

The fruits were graded into marketable and discarded fruits on the basis of the severity of the disease and pest damages. Overall the fruits from the permanent cover crops had the highest percentage of marketable fruits. Even though the gross yield was bigger from trees grown in the annual cover crop, the crop of marketable fruits was at the same level for the three alleyway management systems due to different

levels of pest attack. In 2001 the amount of marketable fruits was 30 percent higher for apples grown in grass compared to the clover grass and annual cover crop. The varieties Otava, Prima and Florina produced the biggest yields. Vanda had the biggest fruits.

The resistance to apple scab was broken down in most varieties. The varieties: 'Florina', 'Vanda', 'Retina' and 'Redfree' was less infected by apple scab. Only Florina was still fully resistant.

The most common pest that damaging the fruits where different species of tortrix and sawflies. Codling Moth was no problem. Apple scab, fly Speck and Sooty blotch was the most serious diseases. Flyspeck and sooty blotch especially developed the last two years.

Conclusion.

In an unsprayed organic apple orchard the best fruit quality based on fruit colour and the lack of pest and disease damage was obtained in trees grown in an alley way system which gave a nitrogen supply in the lower end of the optimum range.

The varieties: 'Florina', 'Vanda', 'Retina' and 'Redfree' was less infected by apple scab. The resistance to apple scab was broken down in most varieties

Plans for 2003-2004.

Write a scientific article about this trial in late autumn 2003.

Some of the trees will in 2004 as in 2003 be used in Darcof: VII.5. Control of scab in organic apple growing.

Concerning EU-application: REPCO: Replacement of copper fungicides in organic production of apple and grapevine I Europe, are we almost 100 percent sure that we are a part of the project. We are invited to the 'kick off' meeting I December 2003, but we still need the final signatures. Some trees will maybe be used in this project.

Cultural techniques 1 and 2.

As the cover crop trial showed an increasing infection of diseases with an increasing nitrogen level and a tendency to a lower yield with lower nitrogen the goal is to find the optimum level of nitrogen in the soil and plants in relation to the disease infection.

To investigate this, two new trials were planted in April 2001. Since the aim is to investigate the apple scab infection in relation to soil treatment the non-resistant varieties 'Discovery' and 'Ingrid Marie' was chosen. They can be infected by apple scab, but are recommended for organic production because they are less susceptible. The trees have been well established in very dense planting systems. Due to problems buying uniform plant material we had to establish one-year-old trees. The optimum would have been two-year-old trees. Therefore it was decided to give the trees one-year of optimal growth conditions (drip irrigation and no weed competition) before we establish the fertiliser treatments. In spring 2002 the 6 fertiliser treatments were established.

Variety: Discovery.

Soil treatments in the rows:

1. Mechanical cleaning, no fertiliser
2. Mechanical cleaning, fertigation with water and biovinasse, product from beer industry (allowed for organic production).
3. Mechanical cleaning, poultry fertiliser (allowed for organic production).

4. Mechanical cleaning, poultry fertiliser and drip watering.
5. Mechanical cleaning, fertigation with water and liquid manure.
6. 20 cm straw from wheat.

In the variety 'Discovery' all soil treatments are replicated 3 times and combined with 4 rootstocks and three planting densities. Each plot comprises 4 trees, in total 874 trees have been planted. Rootstocks: M9, B9 (early terminal bud development), M26 and MM106 (Late terminal bud development). Planting distances: 0.6m, 0.9 m and 1.2 meter.

Variety: Ingrid Marie.

Soil treatments in the rows:

1. Weed in the tree row.
2. Mechanical cleaning, no fertiliser
3. Mechanical cleaning, poultry fertiliser (allowed for organic production).
4. Mechanical cleaning, poultry fertiliser and watering.
5. Mechanical cleaning, poultry fertiliser, root pruning later when we want to reduce vegetative growth.
6. Mechanical cleaning, no fertiliser (As were not able to get the fertiliser 'Agrigro' this is a émtý' treatment' (In the new EU-project we want to try compost as a slow release fertiliser).

In the variety 'Ingrid Marie' all soil treatments are replicated 4 times and combined with 4 rootstocks and three planting densities. Four trees constitute a plot, and in total 1120 tree have been planted. Rootstocks: M9, B9 (early terminal bud development), M26 and MM106 (Late terminal bud development). Planting distances: 0.6m, 0.9 m and 1.2 meter.

The trails are now fully established. The trees grew well in 2002 and 2003. We expected a small yield in 2002, but as 2002 was a warm summer with many insects infestation we lost most of the crop to apple saw flies. In 2003 we still had many apple saw flies flying during flowering and we decided to spray with quassia to be sure that we would get some yield. We spayed twice, but still the crop was reduced compared to an optimal yield.

Data collected:

Trunk diameter was collected just before establishment of the treatments and then after growth 20002. Table 1 shows the tree growth in 2002. Infections of fruit tree canker and apple scab on leaves were evaluated late season 2002 and 2003. Leaf samples were taken in every plot in 2002 and 2003. Table 2 shows the mineral content of the leaves in 2002. Soil samples (N-min) to investigate the nitrogen content and supply were taken in April, June and September 2003. Percentage of water in the upper 50 cm of the soil surface to show the water use of cover crop and the tree supply were taken weekly in the growing period 2003. Visual control of pests and predators was carried out after flowering to see the effect of cover crops and the insect's populations.

The fruits are harvested in August and September 2003. Yield, fruit size and outer fruit quality will be recorded autumn 2003 after cool storage.

Inner fruit quality of the variety Ingrid Marie on rootstock M9 with focus on effect of soil treatments and the planting distance was carried out late September in the laboratory. The following analyses were done: Mineral analyses, fruit firmness, sugar,

starch, colour and fruit weight.

Unfortunately the yield was low in 2003 due to infestation of apple sawflies. Therefore we were not able to do special research in optimal picking date and the inner fruit quality of Discovery cannot be carried out due to a very low yield.

Table 1.

Stammetilvækst i mm per træ for Discovery i mark 33 og Ingrid Marie i mark 35, 2002.

| Discovery | | | | | |
|----------------------------|--------------|--------------|--------------|--------------|-------------------|
| <i>Behandling</i> | B9 | M9 | M26 | MM106 | Behandling |
| Renholdt, ingen N. | 6,6 a | 6,4 a | 8,6 a | 9,8 a | 7,2 a |
| Biovinasse + vand | 6,3 a | 5,9 a | 8,7 a | 9,1 ab | 6,8 a |
| Biandan | 6,8 a | 5,7 a | 8,3 a | 10,1 a | 7,0 a |
| Binadan + vand | 6,5 a | 6,5 a | 9,2 a | 7,8 b | 7,0 a |
| Ajle + vand | 6,9 a | 6,5 a | 8,2 a | 9,7 a | 7,3 a |
| Halm | 6,1 a | 4,8 b | 7,0 b | 8,9 ab | 6,1 b |
| Grundstamme | 6,5 c | 6,0 d | 8,4 b | 9,2 a | |
| Ingrid Marie | | | | | |
| <i>Behandling</i> | B9 | M9 | M26 | MM106 | Behandling |
| Ukrudt | 5,3 d | 5,4 d | 6,2 c | 5,7 b | 5,5 e |
| Renholdt, ingen N | 6,6 c | 6,5 cd | 6,7 bc | 8,8 a | 6,9 d |
| Biandan | 10,3 a | 8,0 b | 9,9 a | 10,5 a | 9,4 ab |
| Binadan + vand | 9,1 ab | 7,4 bc | 9,3 ab | 10,2 a | 8,6 bc |
| Binadan + vand+rodsøkering | 10,2 a | 9,6 a | 10,5 a | 10,4 a | 10,0 a |
| Renholdt, ingen N | 8,3 b | 7,0 bc | 9,1 ab | 5,7 b | 7,9 c |
| Grundstamme | 8,3 a | 7,3 b | 8,6 a | 8,9 a | |

Table 2.

Bladanalyser for Discovery i mark 33 og Ingrid Marie i mark 35, 2002.

| Discovery | | | | | | |
|----------------------------|----------------|---------------|---------------|---------------|---------------|-------------|
| <i>Behandling</i> | total n | P | K | Mg | Ca | B |
| Renholdt, ingen N. | 2,20 a | 0,18 bc | 1,89 ab | 0,17 ab | 0,89 a | 22 a |
| Biovinasse + vand | 2,16 a | 0,20 bc | 1,63 b | 0,18 ab | 0,86 a | 25 a |
| Biandan | 2,28 a | 0,17 c | 1,85 ab | 0,19 a | 0,95 a | 24 a |
| Binadan + vand | 2,29 a | 0,21 bc | 1,72 ab | 0,17 ab | 0,93 a | 24 a |
| ajle + vand | 2,15 a | 0,21 bc | 1,77 ab | 0,16 ab | 0,97 a | 25 a |
| Halm | 2,08 a | 0,28 a | 2,02 a | 0,12 b | 0,95 a | 30 a |
| Ingrid Marie | | | | | | |
| <i>Behandling</i> | total n | P | K | Mg | Ca | B |
| Ukrudt | 1,75 a | 0,50 a | 1,66 a | 0,13 b | 1,16 a | 28 a |
| Renholdt, ingen N | 1,83 a | 0,34 bc | 1,47 a | 0,14 ab | 1,09 a | 23 ab |
| Biandan | 1,95 a | 0,27 c | 1,51 a | 0,16 a | 1,06 a | 21 b |
| Binadan + vand | 1,84 a | 0,41 ab | 1,65 a | 0,17 a | 1,07 a | 24 ab |
| Binadan + vand+rodsøkering | 1,80 a | 0,33 bc | 1,44 a | 0,15 ab | 1,02 a | 25 ab |
| Renholdt, ingen N | 1,63 a | 0,32 bc | 1,68 a | 0,16 a | 1,04 a | 25 ab |

European Study trip.

To be updated in current research activities on organic fruit production, Hanne Lindhard Pedersen visited relevant institutions through Europe during the summer 2003. Focus was on fruit quality and methods used to determine organic quality.

A report is written in Danish.

Conclusions from report about rootstock effect on shoot termination.

1. If organic growers wish a very vigour rootstock it is recommended to try A2 as it has a very early development of terminal bud.
2. M9 and B9 are potential rootstocks for organic production also because they have early terminal bud development.
3. MM106 has the lasted terminal bud development and maybe it should not longer be recommended for organic production.
4. Combinations of varieties and rootstocks are important for the terminal bud development. Combination relevant for organic production has not been tested.

Conclusion:

The trails are now fully established. The trees had a fine growth in 2002 and 2003. Unfortunately a heavy attack of the pest apples saw fly the yield was low in 2002 and 2003 even we in 2003 decided to spay with the pesticide Quassia. Quassia is allowed for organic fruit production in the European quidelines and in Denmark some organic growers have a single year dispensation to use the pesticide.

As a result of the low yield we were not able to carry out research of optimal picking time and inner fruit quality of the variety Discovery.

Else the trial is running fine and the results from 2003 will be calculated during winter 2003/2004.

This trial includes many of the very actual questions in organic apple research in Europe. Therefore we are now a part of the big EU-project "Qualitylowinputfood", where contract negotiations are running in this very moment.

Plans for 2003 and 2004.

The data collection from the growing season 2003 will be finished and results will be calculated.

Hopefully there will be a kick off meting for the EU-project " Qualitylowinputfood".

In autumn 2003 a scientific international article will be writing on the results: Rootstock effect on shot termination.

In February the 11th International Conference on Cultivation technique and Phytopathological problems in Organic Fruit-Growing will take part and the project leaded will participate.

Research as planned for the season 2004 will be carried out.

C.2 Fulfilment of deliverables and milestones

| WP1 Reducing apple scab infection risk using cultural methods. | Time schedule according to application | Deviations, if any* |
|---|--|---------------------|
| Deliverables | | |
| D1. Report about rootstock effect on shoot termination | Apr. 2001 | Done |
| D2, D5, D6, D7. Annual reports | Sep. 2001, 2002, 2003. | Done |
| D3. National article cover crop | Mar. 2002 | Done |
| D4. International article cover crop | April 2002 | Done |
| D8. National publication cultural techniques and fruit quality | Dec. 2004 | |
| D9. International publications cultural techniques, effects on yield, external and internal fruit quality | Dec. 2004 | |
| Milestones | | |
| M 1. Planing of new trail | Winter 2000/2001 | Done |
| M 2. Report on terminal bud development | Spring 2001 | Done |
| M 3. Data analysing | Winter every year | |
| M 4. Growers and consultants are informed yearly about the results in annual reports and field days. | Every year in February and September. | |
| M 5. National article about cover crop effects | Spring 2002 | Done |
| M 6. International article about cover crop effects | Spring 2002 | Done |
| M 7. Visiting scientist at FiBL and study tour through Europe. | Summer 2003 | Done* |
| M 8. Planning and execution of fruit quality analyses | Autumn 2003 | Done |
| M 9. Execution of fruit quality analyses | Autumn 2003 | Done* |
| M 10. National article about cultural practises and fruit quality. | Winter 2004/2005 | |
| M 11. International article about cultural practises, effects on yield, external and internal fruit quality | Winter 2004/2005 | |

* *Deviations are to be further discussed in D*

D. Description of deviations and subsequent adjustments of plans

WP 1

Reducing apple scab infection risk using cultural methods.

Two international articles about the 'cover crops' was written and two talks were given at:

Lindhard Pedersen H. and Bertelsen M. 2002. Alleyway groundcover management and scab resistand apple varieties. ECO-FRU-VIT. 10th International Conference on Cultivation technique and Phytopathological problems in Organic Fruit-Growing and Viticulture. P. 16-21.

and

Pedersen, H. Lindhard and Bertelsen M. 2002. Lower nitrogen supply gave better fruit quality in organic apples. NJF-seminar. No 346. Organic production of fruit and Berries. Published on www.njf.dk.

But still the project leader thinks it is possible to publish more scientific results. Therefore it is planed to write a scientific article in winter 2003/2004.

Also a small scientific article of the results in the rootstock report is planed to be written in autumn 2003.

Unfortunately the yield was low in 2003. Therefore we were not able to carry out al the inner fruit quality analyses as planed for 2003. Therefore we want to transfer some of the money to 2004 to be able also to do work on fruit quality in 2004.

During summer 2003 a study trip through Europe was carried out. It was not possible to stay more days as visiting scientist at FIBL as original planned. Therefore the travel expenses were not as high as expected.

E. Project publications and other products

1. Articles in international, scientific journals with review procedures

B.F. Kühn, T. Toldam Andersen & H. Lindhard Pedersen. 2003. Evaluation of 14 old unsprayed apple varieties. *Biological Agriculture & Horticulture* Volume 20(4), accepted August 2002 and should appear around April/May 2003.

2. Papers presented at congresses, symposiums, etc.

Hanne Lindhard, Maren Korsgaard and Holger Daugaard, October 2000. Organic fruit production in Denmark. Growers Experiences in Denmark. Organic Fruit Opportunities and Challengens. 16-17 October 2000. **

Ole Callesen, Hanne Lindhard and Holger Daugaard, October 2000. Research and development needs for organic fruit production. Organic Fruit Opportunities and Challengens. 16-17 October 2000. **

Lindhard Pedersen H. and Bertelsen M. 2002. Alleyway groundcover management and scab resistand apple varieties. ECO-FRU-VIT. 10th International Conference on Cultivation technique and Phytopathological problems in Organic Fruit-Growing and Viticulture. P. 16-21.

Pedersen, H. Lindhard and Bertelsen M. 2002. Lower nitrogen supply gave better fruit quality in organic apples. NJF-seminar. No 346. Organic production of fruit and Berries. Published on www.njf.dk.

Brandt, K., Ejlersen, A., Nørbæk R., and Lindhard Pedersen H., 2003. Effects of cultivation conditions for apples and growth rates of fruit fly larvae and contents of phenolics. Poster til Levnedsmiddel kongres i København april 2003.

3. Reports, articles in agricultural journals, etc.

Lindhard Pedersen, H. 2000. Æbler uden kemi, Bidrag til årsberetningen. 2000. DJF, afd. For vegetabiliske fødevarer, forskergruppe for frugt og bær.

Lindhard, H.2000. Dækkulturer og skurvresistente æblesorter, Forskningsnytt i Norden, august s. 13-16.

Lindhard, H. 2000. Økologisk frugt og bær: Et langt, sejt træk. Leder i Forskningsnytt i Norden. August s.1-2.

Lindhard H. og Marianne Bengtsson. 2000. Genvejen bruges i kampen mod æbleskurv. Frugt og Bær 11/2000, s. 274-275. *

Kühn, B.F. & Thybo, A., 2000. Sådan smager de skurvresistente æblesorter. Frugt & Bær 29, 242-243. **

*Daugaard, H., K. Thorup-Kristensen, L. Petersen, B. Leonhard, H. Lindhard, M. Korsgaard, B. Rasmussen, J. Solvang, O. B. Hansen og J. Jensen 2001. Vurdering af økologisk produktion i gartneri og frugtavl. Rapport til Kirsten Jensen Udvalget. 103 pp.**

Kühn, B.F., 2001. Perspektiver for skurvresistente æblesorter. Gartner Tidende 117(31), 12-13.*

Jørgensen Gitte Hallengreen, Lindhard Pedersen H. og Philipsen H. 2001. Vælg den rigtige type feromonfælde til viklere. Frugt og Bær. 4/2001, s. 88-90. *

Lindhard H. et. Callesen O. 2001. La production fruitiere biologique en Europe. Le Fruit Belge, s.111-114.**

Lindhard H. 2001. Plant et Frugttræ. Grøn Viden, Havebrug. September 2001. *

Lindhard H. 2001. Vurdering af mulighederne for forebyggelse og alternativ bekæmpelse i frugt og bær. Rapport til Kirsten Jensen udvalget.*

Lindhard H. 2002. Nye æbler på vej. Økologisk Jordbrug.nr. 270. S 6.

Lindhard H. 2003. Æblerne tegner godt. Økologisk Jordbrug. 23, 290. s.8.

Lindhard H. og Bertelsen M. 2003. Flotte øko-æbler ved lavt kvælstofniveau. Frugt og Grønt 6, 254-255.

Lindhard. H. 2003. Nye æbler på vej. Økologisk Jordbrug, 23, 296, s. 6.

Kühn B. F og Lindhard H. 2003. Gamle æblesorter er modtagelige for sygdom. Økologisk Jordbrug 23, s 294.**

Kühn, B. F. og Lindhard, H. 2003. Er gamle æblesorter velegnede til økologisk dyrkning? Nyhedsbrevet Danmarks Jordbrugsforskning. Nr. 5 sep. 2003. s.8. **

Lindhard H. 2003. Intensiv økologisk æbleproduktion kan lade sig gøre. Nyhedsbrevet Danmarks Jordbrugsforskning. Nr. 5 sep. 2003. s.1-2.

Lindhard H. 2003. Store tab på økologiske æbler. Landbrugsavisen. Den faglige baggrund. 19. sep s. 32.

Lindhard H. 2003. Rapport om studierejse angående økologisk æbleforskning i Europa med fokus på frugtkvalitet. Sommeren 2003. Intern rapport pp 10.

4. Oral presentations, public meetings, field days, etc.

Cover crops for scab resistant apple varieties. Nordic scientist meeting 28-29 September 2000. The Agricultural university of Norway.

Evaluation of Swedish fruit and berry project for a Swedish organic scientific research programme. October 2000. Skogs- och Jordbrukets Forskningsråd (SJFR). *

Exhibition of scabresistant apple varieties at the organic congress at Bræstrup. November 2000.

Collaboration meeting among organic scientists in Europe. 29-30. November 2000. Switzerland. Frigg. FIBL. HLP.

Invited speaker to sweden. Resistant varieties at distrikt Vests årsmøde, 15. January 2001 Helsingborg Sweden.

Control and prevention of apple scab. Talk at organic meeting at Flakkebjerg. Marts 2001.

Education of organic apple growers. Koldkærgaard. 14. marts 2001

Field day for organic growers. 9. August 2001

Field day, for organic and traditional growers. 6. August 2001

Field day for traditional apple growers. 4. September 2001*

Education of organic apple growers. Lolland June 2002.

Field day for organic and traditional growers may 2002.

40 Visitors from Czech republic especially interested in organic apple production. May 2002 *

Field day for organic growers, August 2002.

EU journalist visiting interested in organic apple production. Sep. 2002.

Public open day 5 October 2002.

Organiser of the NJF-seminar: Organic production of fruits and berries. 22nd Oct 2002.*

Participate in the Danish Organic Congress, Intensive apple production. 21st Nov. 2002.

Participate in the organic EUGROF-meeting at Fibl, Frick, chairman of a session. 28-29th November 2002.

Nordic fruit growers visiting in combination with * Nordic fruit growers course'. Field day and talk. 28th January 2003.

Talk at Ph.d. course in Sweden. Subject: Results for organic apple research. 4th Marts 2003.

European study trip in June and July 2003.

Field day for organic growers 7th August 2003.

Field day for traditional growers 20th August 2003. *

Talk for Swedish fruit growers at 'Fejø-Forsøgsplantage'. Subject: Results from cover crop trial. 8th August 2003.

F. Scientific education

None

G. National and international cooperation

National:

Kirsten Brandt, Organic food and health – a multigeneration animal experiment. Darcof project no. III.4.

John Hockenhull and Marianne Bengtsson. Royal Veterinary and Agricultural University, Department of Plant Biology, Frederiksberg C, Denmark). Control of scab in organic apple growing (Stop Scab) Darcof project no. VII.5

Maren Korsgaard. Demonstration project for organic fruit and berry production, Industrivej 31 C, 4230 Skælskør, Denmark

International:

Marc Trapman, Private, Dutch organic consultant, specialised in development of an advanced apple scab warning system.

H. Critical reflection on the project

WP1. Reducing apple scab infection risk using cultural methods.

This project is in the great lines running according to plans. There has again in 2002/2003 been a big outcome of the project with 3 publications at seminars and congresses, and 7 publications in agricultural journals. The project have organised a NJF-seminar and results from the project have been shown at 3 open days.

International the project is part of EUGROF, a group of organic fruit and berry scientist, a European study trip has been carried out and the knowledge from the project is the background for participating in two new EU-projects.

Hopefully there will be a kick off meeting for the EU-project "Qualitylowinputfood" early 2004. We are invited to the 'kick off' meeting 1 December 2003 to the EU-project: REPCO: Replacement of copper fungicides in organic production of apple and grapevine in Europe. Being invited to participate in this two projects shows that we do relevant research.

In 2004 some of the old trees will be used in the project DARCOF VII, 5: Control of scab in organic apples growing (Stop Scab).

Even there have been two international presentations of results from the project a scientific international publication or two is still to be written. Writing of this publications will be of the highest priority in the project during the winter 2003/2004.

Due to low crop in 2003 the project asks for transfer of money to 2004 to do some of the planned fruit quality analyses.

The study trip through Europe was cheaper as planned, therefore, the project asks for transfer of travelling money to 2004. Thereby the project leader will be able to take part in the: 11th International Conference on Cultivation technique and Phytopathological problems in Organic Fruit-Growing and Viticulture. In Weinsberg, Germany, February 2004.

The yield was low or nearly not existing in 2002, due to a heavy attack of the pest: apples sawfly. Therefore we decided in 2003 to spray with the pesticide Quassia. Quassia is allowed for organic fruit production in the European guidelines and in Denmark some organic growers have had dispensation to use Quassia in 2001-2003. Apple saw flies have been a big problem for many organic apple growers the last 3-5 years. It is especially the early variety 'Discovery' that is infested. Also 'Ingrid Marie' is infested in warm springs. A heavy infestation causes a 100 percent loss of yield. Quassia is 70-80 percent effective against the larvae of the apple sawfly. This was the result of trials ran by 'Flakkebjerg' at growers sites. The trials were paid by a group of four organic apple growers. During the testing period of Quassia the 4 growers became a dispensation from the Ministry of Environment to use Quassia in their orchards. The growers used quassia had significant higher yields especially in the variety 'Discovery' in those years. The growers now want to apply for a permanent permit to use quassia in Denmark. But this is expensive and time consuming and therefore difficult for a small group of private growers to do the needed paperwork.

One of the four growers did not use quassia. He now decided to stop being an organic apple grower, because he has not harvested fruit in his 4 ha orchard in 2002 and 2003, especially due to infestation of apple saw flies

Quassia is not sold in Denmark as a pesticide, but you can buy it as herb tea and quassia is used as herbal medicine to control malaria in the tropical countries where the trees grow.

In an intensive research programme paid over 5 years it is crucial to have yield in the project period. The aim of this project is to investigate outer and inner fruit quality caused by growing factors. For this we need apples. An alternative to the quassia use could be to extend the project period and hope for a change in the population dynamic of the apple sawfly.

8. Budget

A. Account for any change in budgets

Only budget for the original WP2 now called WP1 is shown.

As the crop was low in 2003, due to high infestation of the pest: apple sawfly, it was not possible to do detailed research of optimum harvest time and inner fruit quality in the variety Discovery in 2003. Therefore I hereby ask for transfer of salary and cost to cover fruit analyses from year 2003 to year 2004. In total transfer of salary for ½ scientific month, 1 technical month and 15.000 Dkr to cover expenses of fruit analyses is wished.

The study travel through Europe was not as expensive as expected. In February 2004 the biannual conference in organic fruit growing in Weinsberg, Germany is taking place. I hereby ask for transfer of 20.000 Dkr. to cover expenses to participate in this conference.

Including indirect costs this is a transfer of total Danish crones: 99.600,- from the 2003 budget to the 2004 budget.

In the following budget I have made the changes according to wished budget changes.

B. Budget for the whole project (1.000 DKK)

| Year: | Consumption before 2003 | Expected consumption 2003 | 2004 | 2005 | Total |
|----------------------|-------------------------|---------------------------|------|------|-------|
| Man-months | 15 | 6.5 | 7 | 0 | 28.5 |
| Scientific personnel | 5 | 2.5 | 2.5 | 0 | 10 |
| Technical personnel | 10 | 4 | 4.5 | 0 | 18.5 |

| Year: | Consumption before 2003 | Expected consumption 2003 | 2004 | 2005 | Total |
|--------------------------------------|-------------------------|---------------------------|-------|------|---------|
| Salaries | 437.5 | 197.5 | 210.5 | 0 | 845.5 |
| Scientific personnel | 187.5 | 96.2 | 96.3 | 0 | 380.0 |
| Technical personnel | 250 | 101.3 | 114.2 | 0 | 465.5 |
| Other operational costs | 0 | 20 | 20 | 0 | 40 |
| Equipment | 105.8 | 5 | 5 | 0 | 115.8 |
| Others (soil and leaf analyses) | 35 | 20 | 20 | 0 | 75 |
| Fruit analyses | | 10 | 39 | 0 | 49 |
| Direct costs | 578.3 | 252.5 | 294.5 | 0 | 1.125.3 |
| Indirect costs (20% of direct costs) | 115.7 | 50.5 | 58.9 | 0 | 225.1 |
| Total | 694 | 303.0 | 353.4 | 0 | 1.350.4 |

Comments:

9. Signatures and stamps

| Name | Institute | Date | Signature |
|---|--|-------------------------------|-----------|
| Head of project: Hanne Lindhard Pedersen | Danish Institute of Agricultural science. Department of Horticulture. | 29 th of September | |

Dansk sammendrag.

Udvikling af bæredygtigt produktionssystem for økologisk æble dyrkning

Projektnummer og -titel

I.2 Udvikling af bæredygtigt produktionssystem for økologisk æble dyrkning

Projektleder

Hanne Lindhard Pedersen, seniorforsker, Danmarks JordbrugsForskning. Afdeling for Prydplanter og Vegetabiliske fødevarer, Forskergruppe for Frugt og Bær, Postboks 102, 5792 Årslev.

Tlf.: 63904171, Fax: 63 90 43 96

E-mail: Hanne.Lindhard@agrsci.dk

Projektdeltager

Marianne Bertelsen, DJF

Delprojekter

| Nr. | Titel | Ansvarlig | Budget (1.000 kr.) | Start | Slut |
|-----|---|----------------|-----------------------|-------|------|
| 1 | Reducere æbleskurvinfektion ved brug af optimeret dyrkningsteknik | Hanne Lindhard | 1.350 | 2000 | 2004 |

Sammendrag

Det totale økologiske areal med frugt og bær i Danmark er ca. 350 ha, heraf er 72 ha æbler og 63 ha er uspecificeret træfrugt. 5 procent af det totale frugtareal er økologisk. Æbler sælges oftest til frisk konsum, det betyder, at produkterne skal leve op til meget høje kvalitetskrav. Som grundregel skal frugterne opfylde størrelseskravene, være hele og sunde.

Den skadevolder, som oftest forhindrer en god ydre kvalitet af frugten, er æbleskurv. Skurv forårsager brune til sorte pletter på frugten og kan i nogle år og på nogle sorter angribe så kraftigt, at æblerne bliver meget små, misdannede og fuldstændig uegnede til spisning. Denne svampesygdom er årsag til et stor udbytte og en meget stor kvalitetsnedgang i økologisk produktion.

Udbyttet af udvalgte sorter hos økologiske avlere ligger fra 0-50 procent af udbyttet hos traditionelle avlere. I gennemsnit for 6 æblesorter var udbyttet hos økologiske avlere på 14 procent af de traditionelle udbytter. For at få den samme indtjening som en konventionel avler behøver den økologiske avler en salgspris på produktet, som er mindst 100 procent større end de i øjeblikket får.

Mange økologiske avlere bruges økologiske bekæmpelsesmidler for at forsøge at kontrollere svampesygdomme. På dette punkt er økologisk æbleproduktion anderle-

des end mange andre økologiske produktioner. Uden i Europa går diskussionen ikke på om der skal bruges økologiske bekæmpelses midler, men om hvilke produkter, som er mest effektive overfor sygdommen. Kobber, som er et effektivt middel og som bruges til økologiske æbleproduktion i de fleste andre europæiske lande, er ikke længere godkendt i Danmark.

Forskning i økologisk æbleproduktion er foretaget i Danmarks JordbrugsForskning siden 1987. Arbejde med at undersøges forebyggende metoder til at undgå æbleskurv infektioner har været en væsentlig del. En af de vigtigste metoder til at forebygge æbleskurv er at plante modstandsdygtige eller resistente sorter. Det forventede totale forbud mod kobber i EU, samt en begyndende nedbrydning af V_f resistensen i de skurvresistente sorter har yderligere forværret udsigterne for en økonomiske rentabel æbleproduktion.

Af dyrkningstekniske tiltag, som kan reducere angreb af æbleskurv, er det vigtigt at have mindre åbne træer med en moderat vækst. Derved bliver infektionsbetingelserne for æbleskurv reduceret.

Niveauet af tilgængeligt kvælstof har vist sig også at påvirke angrebet af æbleskurv. Hvis træer har en hurtigere og længere vækstsæson forbedres skurvens infektionsbetingelser. En øget tilførsel af kvælstof vil også reducere plantens indhold af phenoler. Dette øger også æbleskurvens muligheder for at trænge ind i planten.

Formål

For at forebygge æbleskurv og dermed forbedre kvaliteten og udbyttet i en økologiske æbleproduktion ønskes der i projektet satses på at finde den bedste kombination af kvælstofforbrug, grundstamme og planteafstand til at forebygge æbleskurv infektioner og forbedre produktiviteten.

1: Reducere æbleskurvinfektion ved brug af optimeret dyrkningsteknik.

For at optimere den økologiske æbleproduktion er en ny moderne forsøgsplantning etableret. Her undersøges effekten af gødskning, grundstammer, planteafstand og rodbeskæring på angreb af æbleskurv, udbytte og frugtkvalitet. For at undersøge disse effekter er der valgt sorter, som er modstandsdygtige, men ikke resistente overfor æbleskurv. Sprøjtning med svovl vil blive udført ved store udslyngninger af askosporer. Varslingsprogrammet RIMpro bruges til forudsigelse af disse alvorlige infektionsperioder.

Status 2003

Reduceret æbleskurvinfektion ved brug af optimeret dyrkningsteknik.

Dækafgrøder:

Dette forsøg blev afsluttet efter vækstsæsonen 2001. Men træerne blev ikke ryddet da de bruges i FØJO-projektet: VII.5: Control of scab in organic apple growing (Stop Scab).

Resultaterne fra dette forsøg betød, at vi blev inviteret til at deltage i EU-ansøgningen: REPCO: Replacement of cobber fungicides in organic production of apple and grapevine in Europe. Vi er næsten sikre på at dette projekt realiseres, da vi er inviteret til opstartsmøde midt i december 2003.

Resultater fra dækafgrødeforsøget:

De følgende dækafgrøder blev etableret i kørebanen i 1994. der holdes mekanisk rent i træerækken. Forsøget er ugødet og usprøjtet.

1. En svagt voksende græsblanding (golf) (*Festuca rubra* and *Poa pratensis*).
2. Kløvergræs (*Trifolium repens* and *Lolium perenne*)
3. Enårig dækafgrøde (*Lolium multiflorum* and *Trifolium resupinatum*). Sås hver år i juli. Jorden holdes sort fra april – juli.

Frugt fra træer groet med en svagtvoksende græsbane havde en mindre tilgængelighed af kvælstof og derved et mindre indhold i træet. Dette gav den bedste frugtfarve. En lavere kvælstof tilførsel, specielt under frugtudvikling resulterede i en bedre frugt-udvikling. 15 tons frugt fra træer i den svagtvoksende græsbane havde røddækfarve på mere end 75 procent af frugten, dette som gennemsnit af 10 sorter i 1999 -og 2001. Kun 8 tons frugt fra træer groet i kløvergræs eller i den enårige dækafgrøde havde mere end 75 procent af overfaden rødfarvet.

Infektionerne af æbleskurv var mere talrige på æbler groet på træer i den enårige dækafgrøde. Denne jordbehandling gav den største tilførsel af kvælstof til træerne. Dette var tilfældet til trods for at bladprøverne viste, at træerne fra alle tre behandlinger havde et kvælstofindhold inden for optimalområdet.

Frugten blev sorteret i salgbar og kassabel frugt på basis af angreb af sygdomme og skadedyr. Frugten fra træer i den svagt voksende græsbane havde den høste andel i procent af salgbar frugt. På trods af, at totaludbyttet var større for træer groet i den enårige dækafgrøde var mængden af salgbar frugt den samme fra de to dyrknings-systemer. Dette skyldes at det procentvise angreb af sygdomme på frugten var større på frugt dyrket ved et højere kvælstof indhold.

I 2001 var mængden af salgbar frugt 30 procent højere på træer groet ved lavere kvælstof end træet groet i den enårige dækafgrøde.

Sorterne Otava, Prima og Florina havde de største udbytter. Vanda havde de største frugter. Skurvresitensen var nedbrudt i de fleste sorter. Sorterne Florina, Retina og Redfree havde kun mindre skader af æbleskurv. Kun Florina opretholder resistensen.

Kulturteknik 1 og 2.

Da dækkulturforsøget viser en stigende infektion af sygdomme med stigende kvælstofniveau og et lavere totaludbytte ved lavere kvælstofniveau er målet at finde optimal niveauet af kvælstof i jorden og planerne i relation til udbytte og sygdomsangreb. For at undersøge dette nærmere blev der plantet 2 nye forsøg i april 2001. Fordi skurvinfektionerne i relation til gødningsniveau ønskes undersøgt er der valgt de ikke skurvresistente sorter Discovery og Ingrid Marie. Disse sorter er stadig forholdsvis sunde og bliver anbefalet til økologisk dyrkning.

Træerne er nu veletablerede i meget tætte intensive plantesystemer. I foråret 2002 blev 6 behandlinger lagt ind i træerækkerne.

I sorten Discovery er alle de valgte behandlinger gentaget 3 gange og kombineret med 4 grundstammer og 3 planteafstande i træerækken. Hver parcel består af 4 træer. Det totale antal træer er 784. Grundstammerne er: M9, B9 (tidlig endeknodannelse), 26 og MM106 (sen endeknodannelse). Planteafstandene er 0.6m, 0.9 m og 1.2 meter.

I sorten Ingrid Marie er jordbehandlingerne i træerækken gentaget 4 gange og kombineret med 4 grundstammer og 3 planteafstande. Hver parcel består af 4 træer. Det totale antal træer er 1120. Grundstammerne er: M9, B9 (tidlig endeknodannelse), 26 og MM106 (sen endeknodannelse). Planteafstandene er 0.6m, 0.9 m and 1.2 meter i træerækken.

Forsøget er nu helt etableret. Træerne havde en flot tilvækst i 2002 og 2003. Vi havde forventet et mindre udbytte i 2002, men på grund af et år med store angreb af æblebladhvæpse kom der intet udbytte af betydning på træerne. I 2003 var der igen mange æblebladhvæpse og vi besluttede at sprøjte med Kvassia for at få et udbytte på træerne. Kvassia er godkendt til brug i økologisk æbledyrkning efter EU-reglerne, men ikke efter de danske regler. Vi sprøjtede to gange, men alligevel var udbyttet reduceret i forhold til optimalt udbytte.

Indsamlede data:

Stammediameteren er blevet målt før og efter vækstperioden 2002. Angreb af frugttrækræft, æblemeldug og æbleskurv er registreret efter vækstsæsonen 2002 og 2003. Der er taget bladprøver i 2002 og 2003, samt taget N-min jordprøver 3 gange i sæsonen 2003. Vandprocenten i de øverste 50 cm af jorden er målt ugentligt gennem sæsonen 2003. Visuellekontroller af skadedyr og nyttedyr er udført før og efter blomstring.

Æblerne er høstet i august og september 2003. Udbyttet, frugtstørrelsen og den ydre frugtkvalitet vil blive undersøgt i efteråret 2003. I øjeblikket ligger frugten på kølelager.

Den indre frugtkvalitet i sorten Ingrid Marie undersøges i laboratoriet. Der analyseres for mineralindhold, fasthed, sukker, stivelse og farve.

Desværre var udbyttet i 2003 så lavt, at det ikke var muligt at foretage specielle undersøgelser af det optimale høsttidspunkt. Desuden er det ikke muligt at undersøge den indre frugtkvalitet for sorten Discovery, fordi udbyttet var meget lavt.

Dette forsøg indeholder mange meget aktuelle emner for økologisk æbleforskning i Europa. Derfor er vi en del af det nye store EU-projekt: "Qualitylowinputfood". Der foregår i øjeblikket kontraktforhandlinger.

Europæisk studietur.

For at blive opdateret i igangværende forskning i økologisk frugtproduktion i Europa besøgte Hanne Lindhard i sommeren relevante forsøges institutioner i Europa. Hovedemnet var frugtkvalitet og metoder til at bestemme økologisk frugtkvalitet. Der er udarbejdet en rapport på dansk.