



Midterm Status Report 2003 and Application for Continuation in 2004 (Revised 24/11-03)

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.14 Control of scab in organic apple growing

3. Head of project

Associate Professor, John Hockenhull, Ph.D, (JH)
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4. Participating institutes

Plant Pathology Section
Department of Plant Biology
The Royal Veterinary and Agricultural University
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Department of Horticulture
The Danish Institute of Agricultural Sciences (DJF)
Research Centre Aarslev
Kirstinebjergvej 10
5792 Aarslev

Department of Crop Protection
The Danish Institute of Agricultural Sciences (DJF)
Research Centre Flakkebjerg
4200 Slagelse

5. Other project staff

KVL: Marianne V. Bengtsson (MVB), Ednar Wulff (EW), Hans Jørgen Lyngs Jørgensen (HJLJ), David B. Collinge (DBC)
DJF: Hanne Lindhard Pedersen (HLP), Klaus Paaske (KP), Rikke Nørbæk (RN)

6. Project period (month, year)

Start of project: April 2002
End of project: October 2004

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

A. Project summary

Apple scab, caused by *Venturia inaequalis*, causes serious losses in quality and yield of organically grown apples in Denmark and elsewhere. Materials available to organic growers in Denmark for the control of scab are largely ineffective and scab is also a growing problem for conventional growers. No eradicated or curative fungicides are available for use by organic growers, and while protective, copper-based fungicides are permitted in most European countries, only sulphur is allowed in Denmark and sulphur is not very effective against scab. With respect for the principles of organic growing, the overriding aim of this proposal is to identify and begin to develop some new approaches and materials for the control of apple scab.

A list of candidate scab control materials, including plant extracts, essential oils, compost tea, biocontrol agents, resistance inducers etc. is being continuously updated and promising materials collected. The list includes materials found through literature studies, searches on the web, through national and international contacts and through establishment of a formalised cooperation with the Danish company Nor-Natur Aps concerning delivery of products of plant extracts and essential oils. Standardised inoculum production and plant inoculation methods have been established and are running routinely. Following artificial inoculation of potted apple trees grown in the greenhouse, a range of the potential control materials have been screened for efficacy against the scab pathogen. As reference material sulphur is used.

Where control of scab is found in the greenhouse screen, the materials are to be further investigated histopathologically to establish the mechanism of control whether it appears to be direct (fungicidal or fungistatic), biological (antibiosis, competition and /or hyperparasitism) or whether it appears to involve an activation of host plant resistance mechanisms (induced resistance). Materials showing activity against the scab pathogen are then tested in organically managed orchards, firstly on single trees and next, (in 2004) for the most promising materials, on blocks of trees. Three promising materials (two plant extracts and one resistance-inducer) from the greenhouse screening and sulphur (reference-material) have been tested on single trees in spring-summer 2003. The treatments have been applied either preventively or curatively when apple scab infection periods occur (mainly primary infections, but also secondary), predicted by the PC-warning program RIMpro. Detailed studies are to be made in 2004 to characterise the effect of selected treatments on the secondary metabolites produced in apples, potentially possessing human disease-preventive properties and work will be initiated on the molecular analysis of defence responses in apple.

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

No.	Work package title	Participants*	Budget (1.000 DKK)	Start	End	Deliverable no(s):
1	Screening of potential material for scab control	<u>JH</u> , MVB, EW	1330.1	April 2002	Oct. 2004	D1.1-D1.10
2	Histopathological investigations of host-pathogen interactions	<u>HJLJ</u> , MVB	336.9	Sept. 2002	May 2004	D2.1-D2.3
3	Orchard testing of selected control compounds and secondary metabolite characterisation	<u>HLP</u> , KP, RN	446	April 2003	Oct. 2004	D3.1-D3.4
4	Molecular analysis of defence responses in apple	<u>DBC</u> , NN	60	Sept. 2003	Oct. 2004	D4.1-D4.2

* Responsible participants are underlined

B. Objectives and expected achievements

The overall aim is to identify and begin to develop new approaches and materials for the control of apple scab. The research has the following objectives:

- Following artificial inoculation of detached leaves and potted apple plants in the greenhouse, screen candidate materials for activity against the apple scab pathogen (WP1)
- Where control of scab is found in the greenhouse screen, determine by means of observations under the microscope, whether the controlling effect appears to be direct (fungicidal or fungistatic), biological (antibiosis, competition and/or hyperparasitism) or whether it appears to involve an activation of host plant resistance mechanisms (WP2). All materials showing activity will be considered for inclusion in further tests.
- Test the most promising anti-fungal materials under orchard conditions firstly on single trees and next, for the most promising materials, on blocks of trees (WP3).
- For a candidate material acting by induced resistance, begin characterisation of the gene expression induced by the treatment in relation to known defence responses (WP4).
- Investigate whether treatment with antifungal materials results in differences in secondary metabolite profiles (phenols and volatiles) in apple material harvested from treated orchard trees (WP3).

C. Midterm results and progress

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

WP1: Screening of candidate materials for scab control

Collection and screening of materials in growth chamber and greenhouse at KVL is progressing. A list of candidate scab control materials, including plant extracts, essential oils, compost tea, biocontrol agents, resistance inducers etc. is continuously updated and the materials are gradually collected. The list (approximately 50) includes materials found through literature studies, searches on the web, through national and international contacts and through establishment of a formalised cooperation with the Danish company Nor-Natur Aps, who supplies the project with some products based on plant extracts and essential oils. Standardised inoculum production and plant inoculation methods are established and are running routinely. Following artificial inoculation of potted apple trees (c.v. 'Jonagored') grown in the greenhouse, a range of the potential control materials have been screened for efficacy against the scab pathogen. As reference material sulphur is used. More than 35 materials have been tested at least once in growth chamber or greenhouse tests. Three materials selected from the greenhouse screenings (two plant extracts and one resistance inducer) were delivered for orchard trials at DJF Spring-Summer 2003. Two bachelor projects and one project group have been connected to the project focusing on induced resistance and biological control with antagonistic fungi and bacteria (*Bacillus* spp.).

WP 2: Histopathological investigations of host-pathogen interactions.

Materials showing effect in the greenhouse screenings are investigated to see whether the controlling effect appears to be direct (fungicidal/fungistatic) or whether it appears to involve activation of host plant resistance mechanisms. The fungicidal/fungistatic effect of individual materials on the germination of conidia of *V. inaequalis* is tested on glass slides. Development of a protocol for identification of control materials operating by initiation of plant resistance mechanism is progressing. One potential resistance inducing material has been selected as the model-material and this has shown effect in the greenhouse screenings. Apple leaves treated with this resistance in-

ducing material, challenged with conidia of *V. inaequalis* were studied by microscopy for signs of resistance in connection with a bachelor project. MVB made a study visit to Institute of Plant Pathology, ETH, Zürich, October 2002, to obtain experience in microscopical techniques for studying the infection biology of *V. inaequalis*.

WP3: Orchard testing of selected control compounds and secondary metabolite characterisation.

Three promising materials (two plant extracts and one resistance-inducer), selected from the greenhouse screenings (WP1) and sulphur (reference-material) have been tested on single trees of c.v. 'Delorina' in an organically managed orchard at DJF in spring-summer 2003. The resistance inducing compound has been applied every 10th day, one of the plant extracts and sulphur were applied preventively, and the other plant extract was applied curatively when apple scab infection periods had occurred (mainly primary infections, but also secondary), predicted by the PC-warning program RIMpro. At the time of writing (30/9-03) not all data are collected and analysed, but preliminary results indicate some effect of all three tested materials.

Parallel, in collaboration with Norwegian and Dutch researchers, one of the plant extracts has been tested as a curative treatment on a larger scale in another trial at DJF. Preliminary results from this experiment seem, too, to indicate that this plant extract has a curative effect on apple scab.

Prediction of the first infection periods in spring 2003 by the RIMpro program seems not to have been so reliable as expected, since discharged ascospores were trapped in the beginning of April, while the program gave no warning at this stage. Early unprotected infections may thus have occurred, which may have been the cause of the severe scab infections experienced this summer at DJF (both in the organic and conventional orchards).

WP4: Molecular analysis of defence responses in apples

Work will be initiated on a molecular analysis of defence responses in apple. We have received an expression of interest to cooperate in this work from the Plant Health and Development research group at HortResearch, Mt Albert Research Centre, Auckland, New Zealand, who work on characterization of defence responses in apple to the apple scab pathogen. This group has developed an apple microarray, which we would use in this work. RNA material from apple leaves showing defence reactions will be extracted at KVL and sent to Auckland, NZ, for analysis and specialized bioinformatics analysis.

C.2 Fulfilment of deliverables and milestones

* *Deviations are to be further discussed in D*

WP 1: Screening of candidate materials for scab control	Time schedule according to application	Deviations, if any*
Deliverables		
1.1 Collection of materials for batch 1	July 2002	√
1.2 Growing of strains of <i>V. inaequalis</i> and establishment of inoculation procedures	August 2002	√
1.3 First screening of batch 1 of scab control materials in growth chambers. Material supplied to WP2 for microscopy	October 2002	√
1.4 Second screening of promising materials for batch 1	January 2003	√
1.5 Collection of materials for batch 2	January 2003	√
1.6 Supply of material to WP3 for orchard experiments (chosen mainly from batch 1)	April 2003	√
1.7 First screening of batch 2 of scab control materials in greenhouse	July 2003	√

1.8 Second screening of promising materials from batch 2	October 2003	On schedule
1.9 In co-operation with WP2, supply of leaf material to WP4 (molecular study of induced resistance)	August 2003 – July 2004	2004
1.10 Supply of material to WP3 for orchard experiments (chosen from batch 1 and 2)	March 2004-July 2004	
Milestones		
1.1 Materials for batch 1 collected	August 2002	√
1.2 Growing and inoculation procedures established	September 2002	√
1.3 First screening of batch 1 completed. Material for microscopy supplied to WP2	October 2002	√
1.4 Second screening of batch 1 completed	January 2003	√
1.5 Materials for the second batch of screening collected	January 2003	√
1.6 Supply of materials to WP3 for orchard testing completed	July 2003	√
1.7 First screening of second batch completed	July 2003	√
1.8 Second screening of batch 2 completed. Material supplied to WP2 for microscopy	October 2003	On schedule
1.9 Supply of materials to WP3 for orchard trials completed*	July 2004	
1.10 Materials for WP3 for orchard trials supplied*	July 2004	
1.11 Supply of leaf material to WP4 completed	July 2004	

* *Deviations are to be further discussed in D*

*Milestone 1.9 and 1.10 are the same

WP 2: Histopathological investigations of host-pathogen interactions	Time schedule according to application	Deviations, if any*
Deliverables		
2.1 A protocol or a set of criteria to be used to test whether induced resistance is involved in protection offered by a control agent	September 2002	Dec. 2003
2.2 Results of test of selected batch 1 material	February 2003	Dec. 2003
2.3 Results of test of selected batch 2 material	March 2004	Dec. 2003
Milestones		
2.1 A protocol for examining whether induced resistance is involved in the protection against disease is established	November 2002	Dec. 2003
2.2 Test of control material in batch 1 for ability to induce resistance completed	February 2003	Dec. 2003
2.3 Test of material in batch 2 for ability to induce resistance is completed	March 2004	

• *Deviations are to be further discussed in D*

WP 3: Orchard testing of selected control compounds and secondary metabolite characterisation	Time schedule according to application	Deviations, if any*
Deliverables		
3.1 Results of field screening of selected compounds	October 2003	On schedule
3.2 Result of field testing of selected compounds in combination with tree growth in 2004	August 2004	
3.3 Analysis of volatiles and phenolic compounds of apples	August–September 2004	
3.4 An international publication in 2004/2005 (together with WP1,2 & 4)	September 2004	
Milestones		
3.1 Selections of promising compounds in 2003	January 2004	
3.2 Testing of promising compounds in 2004	April 2004	

3.3 The analyses of secondary metabolites are completed	September 2004	
3.4 National publication 2004	September 2004	
3.5 International publication	September 2004	

- *Deviations are to be further discussed in D*

WP 4: Molecular analysis of defence responses in apple	Time schedule according to application	Deviations, if any*
Deliverables		
4.1 Microarray data for induced resistance in apple	June 2004	
4.2 One scientific paper in collaboration with collaborators in NZ	September 2004	
Milestones		
4.1 The analyses are completed	September 2004	
4.2 Publication completed	September 2004	

- * *Deviations are to be further discussed in D*

D. Description of deviations and subsequent adjustments of plans

WP 2 *Histological investigations*. Development of a protocol for identification of control materials operating by initiation of plant resistance mechanisms is behind schedule. The main problem is that the histological markers we have been looking for are the ones described in the barley/*Drechslera teres* system by Jørgensen *et al.* 1998 (full reference is cited in the original project description) and it seems that these reactions do not occur or they occur in a significantly different way in the interaction between apple and *Venturia inaequalis*. The model system we have been using consists of apple leaves treated with the resistance inducing material, Bion, challenged with conidia of *Venturia inaequalis*. Induced, challenged leaves are then studied by microscopy for signs of resistance including deposition of barriers and infection abnormalities. Some other types of indications have been observed however, and these we expect to be able to develop as markers for use in the screening work. We have intensified this work and our aim is to have reached this milestone in December 2003.

WP4 *Molecular analysis*. Due to the delay in WP2 outlined above, we have not yet identified an organic material that initiates plant resistance mechanisms in apple leaves. As stated above, we anticipate that we will be in a position to do so by the end of 2003. We plan to carry out the WP4-activities originally planned for 2003 in 2004 in cooperation with the group of HortResearch, Auckland, NZ, and we have made the appropriate adjustments to the budgets for 2003 & 2004.

Staffing of the project. Much of the work concerning screening of putative control materials, their further development and the search for new candidate materials in WP1 and also all of the histological work in WP2 is innovative and has required a larger input from the research staff than was envisaged when the original proposal was written. This has meant that not all of the funds allocated for technical assistance had been used. Therefore, in order to “catch up” on the histological research work in WP2, while still pushing ahead with the screening work etc. in WP1, a further scientist has been employed on the project for a limited period. The scientist, Ednar Wulff (EW), has an excellent research background and has previously worked with non chemical control of foliage diseases. EW is currently working mainly on WP1 while MVB is concentrating mainly on WP2.

Project publications and other products

1. Articles in international, scientific journals with review procedures
2. Papers presented at congresses, symposiums, etc.
 - Bengtsson, M. & Hockenhull, J. 2002. Control of apple scab (*Venturia inaequalis*) in organic growing. StopScab: A Danish research programme for screening substitutes to copper fungicides. Presented as paper, poster and oral presentation at ”The 6th IOBC/WPRS Workshop on Pome Fruit Diseases”, 31.8-5.9.2002, Lindau, Germany. IOBC Bulletin (*In press*)
3. Reports, articles in agricultural journals, etc.

Articles in agricultural journals:

- Bengtsson, M. & Hockenhull, J. 2002. Kampen mod frugttrækraft. Frugt & Grønt

4/2002: 158-159.**

- Hockenhull, J., Bengtsson, M., Jørgensen, H.J.L., Pedersen, H.L., Nørbæk, R. & Paaske, K. 2003. Bekæmpelse af æbleskurv i økologisk frugtavl – kan planteekstrakter, biologisk bekæmpelse og induceret resistens anvendes? *Forskningsnytt for Økologisk Jordbrug i Norden* 2: 26-27.
- Hockenhull, J., Bengtsson, M., Jørgensen, H.J.L., Pedersen, H.L., Nørbæk, R. & Paaske, K. 2003. Bekæmpelse af æbleskurv i økologisk frugtavl – kan planteekstrakter, biologisk bekæmpelse og induceret resistens anvendes? *FØJOenyt* nr.4: <http://www.foejo.dk/enyt2/enyt/aug03/skurv.html>

Reports:

- Kromann Jensen, S. 2003. Apple scab (*Venturia inaequalis*) and induced resistance. Plant Pathology Section, The Royal Veterinary and Agricultural University, Frederiksberg, pp.48. (B.Sc. project report)
- Moth-Poulsen, A. 2003. Biologiske bekæmpelse af æbleskurv forårsaget af *Venturia inaequalis*, med særlig fokus på sommerstadiet. Plant Pathology Section, The Royal Veterinary and Agricultural University, Frederiksberg, pp.57. (B.Sc. project report)

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

Oral presentations:

- Bengtsson, M. “Biocontrol of foliar diseases in fruit trees” presented at the lecture course “Biological Control of Pests and Diseases in Agriculture, Horticulture, and Forestry”, KVL.
- Bengtsson, M. & Hockenhull, J. “Control of apple scab (*Venturia inaequalis*) in organic growing. StopScab: A Danish research programme for screening substitutes to copper fungicides”, presented at ”The 6th IOBC/WPRS Workshop on Pome Fruit Diseases”, 31.8-5.9.2002, Lindau, Germany.
- Bertelsen, M., Bengtsson, M.V., Hockenhull, J. & Pedersen, H.L.: “Control of scab in sustainable apple production”, presented at Nordic Ph.D.Course “Sustainable Production in Horticulture” 4th March 2003, SLU-Alnarp, Sverige.
- Hockenhull, J. & Bengtsson, M. ”Frugttrækraft- Biologi og muligheder for biologisk bekæmpelse”, presented at “Temamøde for Frugt og Bæravlere”, 30th January 2002, DEG Odense.

Poster presentations:

- Bengtsson, M. & Hockenhull, J. “Control of apple scab (*Venturia inaequalis*) in organic growing. StopScab: A Danish research programme for screening substitutes to copper fungicides”, presented at ”The 6th IOBC/WPRS Workshop on Pome Fruit Diseases”, 31.8-5.9.2002, Lindau, Germany.
- Bengtsson, M. & Hockenhull, J. “Control of apple scab (*Venturia inaequalis*) in organic growing. StopScab: A Danish research programme for screening substitutes to copper fungicides” presented at NJF-seminar No 346 “Organic production of Fruit and Berries”, 22nd October 2002, DJF, Aarslev.
- Hockenhull, J., Bengtsson, M.V., Collinge, D.B., Jørgensen, H.J.L., Pedersen, H.L., Paaske, K. & Nørgaard, R.. “Bekæmpelse af skurv i økologiske æbler”, Midterm evaluation of DARCOF II held in Viborg on Wednesday 23rd October, 2002.
- Hockenhull, J., Bengtsson, M.V., Collinge, D.B., Jørgensen, H.J.L., Pedersen, H.L.,

Paaske, K. & Nørgaard, R. "Bekæmpelse af skurv i økologiske æbler", Presented at the course: "Plant Protection in Horticulture", Danish-Swedish Horticulture Programme, 1st October 2003.

Public meetings:

- Bengtsson, M. Jørgensen, H.J.L., Hockenhull, J. Meeting and demonstration of the Stop-Scab project with the "Erfar"-group of organic apple growers in Denmark, 6th August 2003, KVL, Højbakkegård, Tåstrup.
- Bengtsson, M. & Hockenhull, J. Meeting and demonstration of the StopScab project with 12 Swedish organic apple growers, 7th August 2003, KVL, Højbakkegård, Tåstrup.

Field days:

- Bengtsson, M. & Hockenhull, J. Orchard open day arrangement for apple growers, 28th May 2002, Ventegodtgård, Li. Skensved.
- Bengtsson, M. Orchard open day arrangement for apple growers, 21st May 2003, Ventegodtgård, Li. Skensved.
- Bengtsson, M., Hockenhull, J. & Pedersen, H.L. DARCOF - Orchard open day arrangement, 7th August 2003, DJF, Aarslev.

Project staff visits and meetings

- Hockenhull, J. Attended the midterm evaluation of DARCOF II held in Viborg on Wednesday 23rd October, 2002
- Bengtsson, M. & Hockenhull, J. "10th Meeting on Apple Scab" January 15-19 2003, Sambuca di Sicilia, Italy.
- Bengtsson, M. & Hockenhull, J. Attended "Presentation of experiments at Fejø Forsøgsplantage", 19th March 2003, Landbolyst, Fejø.

F. Scientific education

Post doc. Marianne Bengtsson (MVB) made a study visit to Institute of Plant Sciences Pathology, Swiss Federal Institute of Technology, ETH Zürich, Switzerland, October 2002, to get experience in microscopical techniques for studying the infection biology of *V. inaequalis* (being used in WP2: Histopathological investigations of host-pathogen interactions).

Bertelsen, M., Bengtsson, M.V., Hockenhull, J. & Pedersen, H.L. contributed at the Nordic Ph.D. course on "Sustainable Production in Horticulture" 4th March 2003, Alnarp, Sweden, with the lecture 'Control of scab in sustainable apple production' presenting concepts and results from DARCOF projects I.2 (ORGAPPLE) & I. 14 (StopScab).

Two B.Sc students (Agnete Moth-Poulsen & Susanne Kromann Jensen) have made their bachelor projects in plant pathology at KVL: One focusing on biological control of apple scab with antagonistic fungi and the other focusing on induced resistance against apple scab with a commercial compound known to induce resistance in apple against fire blight and in other crops against other pathogens.

Post doc. Marianne Bengtsson (MVB) is following a 1-year (part time) education in pedagogy at KVL, 2003-2004. As part of this activity MVB is giving a lecture on 'Alternative methods for controlling apple scab (*Venturia inaequalis*)' to students attending the KVL course entitled 'Plant Protection', 'Plant Diseases' and 'Biological control of pests and diseases in agriculture, horticultural

ture and forestry' and is co-supervisor for a project group currently working on the topic 'Biological control of apple scab using *Bacillus* spp.'

StopScab contains many topics (at laboratory, semi-field and orchard levels) suitable for research projects by Bachelor, M.Sc. and Ph.D. students. Efforts are continuously being made to make these opportunities known to potentially interested students at KVL and elsewhere. Two enquiries, one from Rumania and another from Poland, have been received proposing research collaboration.

G. National and international cooperation

National:

Internally the research consortium involved in this project is a strong team as it links researchers with different specialisations, coming from different departments and groups at two different institutions (KVL and DJF). Thus, at DJF, three groups are involved, The Research Group for Food Quality and Natural Products Chemistry, The Pomology Research Group and The Research Group for Effects of Pesticides. Participants from KVL belong to different research groups, each with its focus on plant-pathogen interactions: Biological Control Group, Induced Resistance and Histopathology Group and Molecular Plant Pathology Group.

Our research activities are closely linked with DARCOF project I.2 (Development of sustainable production of apples). There are also links between WP3 on secondary metabolites with DARCOF project III.4 (Organic food and health).

We have long-standing and excellent relations with the fruit consultant Svend Ramborg and organic fruit consultant Maren Korsgaard and the organic fruit demonstration orchards on Fejoe. Through our relation to Maren Korsgaard we have contact with the "Erfa"-group of organic apple growers in Denmark.

We have initiated and formalised co-operation with the Danish company Nor-Natur ApS, Kanalhølm 2, DK-2650 Hvidovre, regarding supply of plant extracts and essential oils.

International:

MVB and JH attended the 6th Workshop of Pome Fruit Diseases, 31. August – 5. September 2002, Lindau, Germany. Contacts were strengthened with key researchers working with apple scab including:

- Odile Carisse, Agriculture and Agri-Food Canada, Québec, Canada.
- Cesare Gessler & Eve Silberberg-Dilworth, Institute of Plant Sciences Pathology, Swiss Federal Institute of Technology, ETH Zürich, Switzerland.
- William MacHardy, University of New Hampshire, USA.
- Luciana Parisi, INRA, Beaucauzé, France.
- Arne Stensvand, Norwegian Crop Research Institute, Aas, Norway.
- Christer Torneus, Swedish Board of Agriculture, Alnarp, Sweden.
- Peter Triloff, Marktgemeinschaft Bodenseeobst, Friedrichshafen, Germany.
- Marc Trapmann, Fruit Consult International, The Netherlands.
- Piet Cremers, Royal Research Station of Gorseme, Belgium.

JH & MVB attended the 10th Meeting on Apple Scab, January 2003, Italy, for researchers and consultants working with apple scab in Europe and North America. Here a further collaboration

with Arne Stensvand, Norway, and Marc Trapmann, The Netherlands, was agreed upon concerning orchard testing in 2003 of a plant extract to control apple scab in similar experimental set-ups conducted in Norway, The Netherlands and Denmark..

StopScab was a part of the Expression of Interest submitted in response to Call EOI.FP6.2002 entitled "Integrated approach to sustainable fruit production in united Europe (SUSFRUITPRO)".

Through the meetings in Germany and Italy our contacts with the Dutch researchers Bart Heijne, Applied Plant Research, Zetten, and Jürgen Köhl, Plant Research International, Wageningen was strengthened and participation in the EU proposal, REPCO, was initiated (Further discussed under section H, below).

We have received an expression of interest from the Plant Health and Development group at HortResearch, Mt Albert Research Centre, Auckland, New Zealand, on cooperation on analysis of defence responses in apple in WP 4.

H. Critical reflection on the project

Broadly speaking, the StopScab project progresses according to the original plan. The screening procedures using potted plants in the greenhouse (WP1) is working well but we are also developing detached-leaf and seedling assay systems, that take up less room and will be cheaper to maintain. In 2002/2003, several promising materials were chosen using the potted plant system, and these have been tested under orchard conditions at Aarslev (WP3). In general the results in the orchard supported the finding from the greenhouse screening and it is planned to include these materials in a repeat trial at Aarslev in the 2004 season, in order to verify the results. Also in 2004, several new candidate materials (batch 2) will be undergoing their first orchard test. In batch 2 we plan to include materials that could be prepared by the grower her/himself e.g. extracts of locally available plant species. In the histopathological work (WP2), much valuable experience has been gained. As explained under section D, the protocol we had planned to emulate for the identification of resistance-inducing materials, was based on a different host/pathogen combination than apple/*Venturia inaequalis*. We are now working on developing a protocol based on a new set of histological indicators. Extra resources are being put into this work, and the aim is to have it completed in December this year.

The StopScab project involves researchers with different specializations, from different departments and groups at KVL & DJF. Three highly constructive meetings have been held during the year for discussion of plans, presentation of results and exchange of knowledge and ideas. These meetings were attended by all the project staff and held in turn at the three involved institutions. Agendas and short written minutes were prepared for all of these meetings.

The good collaboration between StopScab partners is further reflected in our expected participation in the coming European Union 6th Framework, 8.1 priority programme entitled Replacement of Copper Eungicides in Organic Production of Grapevine and Apple in Europe (REPCO) with expected kick-off ultimo 2003. The StopScab research platform undoubtedly contributed to our involvement in REPCO, and our participation in this EU project can be expected to have an "added value" as well as a synergistic effect on the research and practical results coming out of StopScab (and ultimately out of REPCO).

During the year we have had visits from groups of apple growers and also participated in several open day events etc. Contact with the practical world of fruit growing has been very stimulating,

and to judge by the interest shown by the growers, it seems that what we are attempting to achieve with the StopScab project, is something that has their interest too.

8. Budget

A. Account for any change in budgets

Concerning the work at the Plant Pathology Section, KVL, scientific man-months are increased with three months in 2003 (See section D). In agreement with the DARCOF secretariat this increased scientific salary is covered mainly from the unused salary of technical personnel budgeted for 2003. One month technical salary is moved from 2003 to 2004. Operational costs, DKK. 30.000, connected to WP4 in 2003 are moved to 2004.

The difference in DKK 46.800 between "Consumption before 2003" in this Midterm Status Report 2003 and last year's "Expected consumption for 2002" is equal to the difference between budget and cost statement for 2002.

B. Budget for the whole project (1.000 DKK)

Total consumption of funds from DARCOF and expected consumption this year and coming years

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	2006	Total
Man-months						
Scientific personnel	9	16	13			38
Technical personnel	0	5	8			13

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	2006	Total
Salaries						
Scientific personnel	247	528	472			1247
Technical personnel	0	142.4	222			364.40
Other operational costs	33	50	114			197
Equipment						
Others (please specify)						
Direct costs	280	720.4	808			1808.4
Indirect costs (20% of direct costs)	56	143.7	161.8			361.5
Total	336	864.1	969.8			2169.90

Comments:

9. Signatures and stamps

Name	Institute	Date	Signature
Head of project John Hockenull		13.10.03	

Appendix I. Detailed budget

A. Budget for each participating institute (1.000 DKr)

Name of Institute:
 Plant Pathology Section
 Department of Plant Biology
 KVL

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	2006	Total
Man-months						
Scientific personnel	9	15	9			33
Technical personnel	0	4	4			8

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	2006	Total
Salaries						
Scientific personnel*	247	490	311			1048
Technical personnel	0	117	114			231
Other operational costs	33	40	84			157
Equipment						
Others (please specify)						
Direct costs	280	647	509			1436
Indirect costs (20% of direct costs)	56	129	102			287
Total	336	776	611			1723

Comments:

*Scientific months based on 32 hours/week

The difference in DKK 46.800 between "Consumption before 2003" in this Midterm Status Report 2003 and last year's "Expected consumption for 2002" is equal to the difference between budget and cost statement for 2002.

B. Budget for each participating department (1.000 DKK)

Name of Institute and department:

Department of Horticulture / Department of Crop Protection

Research Center Aarslev / Research Center Flakkebjerg

DJF

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	2006	Total
Man-months						
Scientific personnel		1	4			5
Technical personnel		1	4			5

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	2006	Total
Salaries						
Scientific personnel		38	161			199
Technical personnel		25.4	108			133.4
Other operational costs		10	30			40
Equipment						
Others (please specify)						
Direct costs		73.4	299			372.4
Indirect costs (20% of direct costs)		14.7	59.8			74.5
Total		88.1	358.8			446.9

Comments:

C. Budget for co-financing from each participating institute (1.000 DKK)

Name of Institute:
 Plant Pathology Section
 Department of Plant Biology
 KVL

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	2006	Total
Man-months						
Scientific personnel	1	2	2			5
Technical personnel		1	1			2

Year:	Consumption before 2003	Expected consumption 2003	2004	2005	2006	Total
Salaries						
Scientific personnel						
Technical personnel						
Other operational costs						
Equipment						
Others (please specify)						
Direct costs						
Indirect costs (20% of direct costs)						
Total						

Comments:

The Department of Plant Biology, KVL, will cover one month's salary for a scientist in 2002, 2003 and 2004 for WP2 and one month's salary for one technician and one scientist in 2003 and 2004 for WP4.