



Annual Status Report 2001 and Application for Continuation in 2002

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

3. Head of project

Hanne Lindhard Pedersen, Seniorscientist
Danish Institute of Agricultural Sciences
Department of Horticulture
Kirstinebjergvej 10
5792 Aarslev
Phone: 63 90 43 43
Fax: 63 90 43 96
E-mail: Hanne.Lindhard@agrsci.dk

4. Participating institutes

Danish Institute of Agricultural Sciences
Department of Horticulture
Kirstinebjergvej 10
5792 Aarslev
Phone: 63 90 43 43
Fax: 63 90 43 96

5. Contact persons

Hanne Lindhard Pedersen, Seniorscientist
Danish Institute of Agricultural Sciences
Department of Horticulture
Kirstinebjergvej 10
5792 Aarslev
Phone: 63 90 43 43
Fax: 63 90 43 96
E-mail: Hanne.Lindhard@agrsci.dk

6. Other project staff

Scientist Birka Falk Kühn, Danish Institute of Agricultural Sciences
Department of Horticulture, Kirstinebjergvej 10, 5792 Aarslev
Phone: 63 90 43 43, Fax: 63 90 43 96, E-mail: Birka.Kuehn@agrsci.dk

Scientist Marianne Bertelsen, Danish Institute of Agricultural Sciences
Department of Horticulture, Kirstinebjergvej 10, 5792 Aarslev, phone: 63 90 43 43
Fax: 63 90 43 96 E-mail: Marianne.Bertelsen@agrsci.dk

7. **Start of project: 2000**
End of project: 2004

8. Annual report/Application for continuation in 2001

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:

To find new resistant varieties suitable for the Danish climate through a close co-operation with the big breeding program in France.

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

WP 1: Early testing of new resistant selections.

WP 2: Reducing apple scab infection risk using cultural methods.

Expected achievement:

WP 1: It is expected to find apple scab resistant varieties suitable for the Danish climate. During the project period annual field days will be carried out. Results will be published in relevant agricultural magazines.

WP 2: 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.

A. 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 objectives are 1. To find new resistant varieties suitable for the Danish climate through a close cooperation with the big breeding program in France. 2. To find the best combination of nitrogen supply, use of rootstocks and planting distance to prevent apple scab infections and improve productivity.

Table 1 Workpackage list

Work-package no.	Workpackage title	Responsible participant	Budget (1.000 Dkr)	Start	End	Delive-rable no.
Apples WP1	Early testing of new resistant selections.	Birka Falk Kühn, Hanne Lindhard	1227	2000	2004	D1, D3, D6, D7, D8, D9 D12.
Apples WP2	Reducing apple scab infection risk using cultural methods.	Marianne Bertelsen Hanne Lindhard	1123	2000	2004	D2, D3, D4, D5, D6, D7, D9, D10, D11.

* Responsible participants are underlined

B. Progress

C.1 Annual description (resume) of main results and conclusions

WP 1: Early testing of new resistant selections.

No agreements have been made with INRA so far, but the project has been discussed and the initial response from INRA is positive. Most of the breeding research is privately funded and royalties and variety rights have not yet been negotiated.

The 7-8th of December is Research manager Ole Callesen visited INRA, France to negotiate an apple variety test-agreement. A collaboration project is draw up and send to France. We are waiting for response. As the contract not yet is signed we hereby ask for extension of WP 1. In that way WP1 is wished running also in year 2005. As apple is a long-term crop this will strengthen the outcome of the project. The wished changes are shown in the budget. See also part 9: Budget.

At Aarslev an enlargement of the organic research area has been carried out, as there were no suitable area inside the already existing area for receiving apple scab resistant seedlings. A suitable field has been pointed out and was cleaned from existing trials winter 2000-2001.

WP 2: Reducing apple scab infection risk using cultural methods.

Cover crop:

The trial planted in 1994 has been harvested and the fruits are stored for later quality grading. Fruit size and colour and skin damages caused by pest and diseases are going to be determined.

Main results:

The following cover crops are established:

A permanent gras mixture of *Festuca rubra* and *Poa pratensis*.

Clover grass mixture of *Trifolium repens* and *Lolium perénne*.

Annual cover crop of *Lolium multiflorúm* and *Trifolium resupinatum*, sown every year in July. The soil has been kept black from April to July.

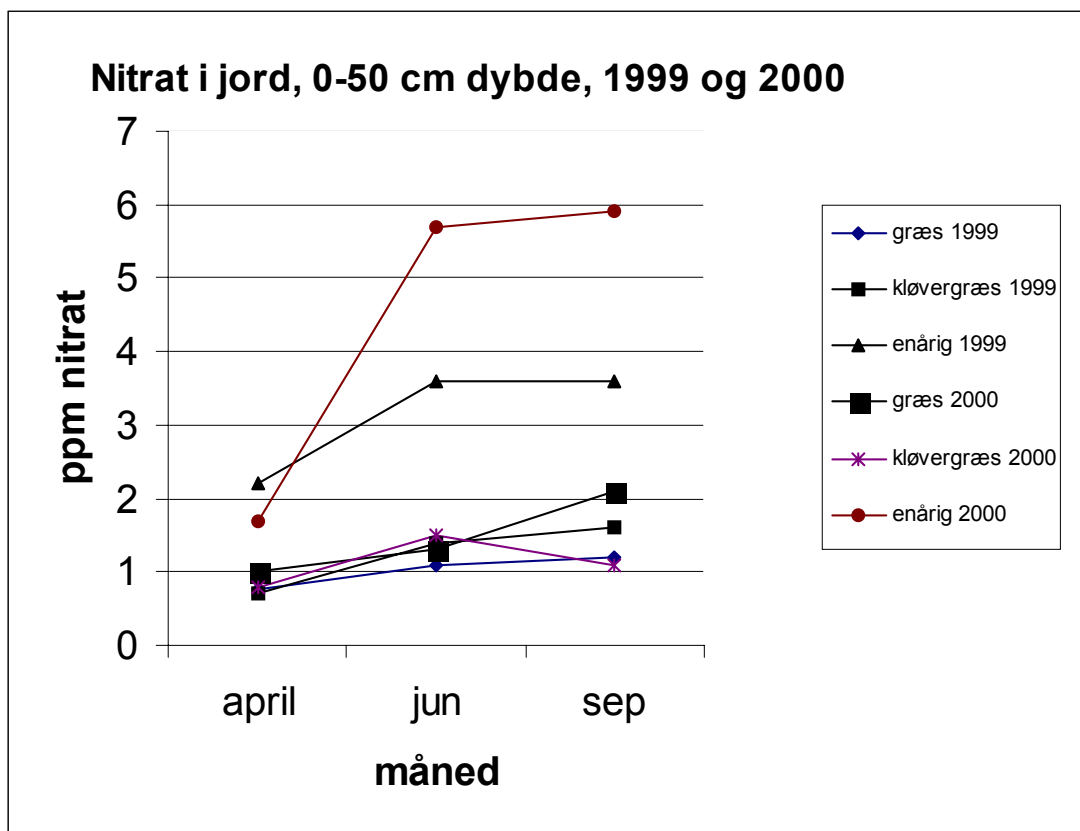


Figure 1 Nitrate in soil, 0-50 cm dept at three dates 1999 and 2000 respectively.

Table 1 Yield in tons per ha. for 3 cover crops, average of 10 varieties. 1996-2000 and percentage of 1. Quality fruits in 2000.

Behandling	Udbytte tons/ha 1996	Udbytte Tons/ha 1997	Udbytte Tons/ha 1998	Udbytte Tons/ha 1999	Udbytte Tons/ha 2000	Total Udbytte 1996-2000	1. Kvalitet Pct frugt 2000
Dæk-kultur							
Treatment	Yield	Yield	Yield	Yield	Yield	Yield	pct. fruit
Grass	1,7 ab	10,9 b	6,7 c	25,6 a	21,8 c	66,7	80 a
Clover grass	1,8 a	10,1 b	9,7 b	22,6 b	25,5 b	69,7	73 b
Annual	1,3 b	12,0 a	12,8 a	21,6 b	30,5 a	78,2	72 b

Table 2 Fruit quality as fruit size and colouring of the skin in 1999 and 2000 for 3 cover crops. Averages of 10 varieties.

Treatment	Fruit size G/100 1999	% fruits < 25 pct colour 1999	% fruits >75 pct Colour 1999	Fruit Size g/100 2000	% fruits < 25 pct Colour 2000	% fruits >75 pct Colour 2000
Grass	146 a	21 b	50 a	138 a	14 c	64 a
Clovergrass	147 a	35 a	32 b	137 a	32 b	37 b
Annual	144 a	36 a	28 b	137 a	39 a	27 c

Table 3 Fruit quality as infection of diseases in 1999 and 2000 for 3 cover crops. Averages of 10 varieties.

Treatment	% fruits	No ann. Shots	% fruits	% fruits	% fruits	% fruits	% fruits
	Without Scab	With powdery mildew	With fly speck	With sotty bloch	Without Scab	With fly speck	With Sotty bloch
	1999	1999	1999	1999	2000	2000	2000
Grass	98 a	6 b	33 b	12 b	90.7 a	15.9 b	10.3 a
Clover grass	91 b	4 b	32 b	13 b	68.8 b	18.3 ab	11.8 a
Annual	59 c	23 a	40 a	18 a	63.0 b	22.6 a	14.4 a

Table 4 Percent fruits without apple scab in 1996 to 2000 for 10 varieties averages of 3 cover crops.

Variety	1996	1997	1998	1999	2000
Prima	100	100	100	97.2	65.5
Redfree	100	100	100	96.6	95.6
Florina	100	100	100	100	100
Vanda	100	100	100	100	99.8
X6398	100	100	100	40.8	1.5
Retina	100	99.8	100	74.6	95.9
Rewena	100	100	99,9	96.7	83.4
Delorina	100	99.7	98,3	68.1	49.1
Otava	100	99.8	96,8	57.5	48.5
Saturn	100	100	99,9	79.7	70.3

Conclusion.

After 4 years yielding the trees growing in the weak grass mixture has cropped in total at the same level as the other treatments. The 5th yielding year the trees in the week grass mixture had a lower yielding than the trees in the annual cover crop (Table 1). The leaf samples and the soil samples (Fig 1) shows that the level of nitrogen in leaves and soil are higher in the soil grown with annual cover crop. Fruit trees need nitrogen to the development of flower clusters. Maybe the nitrogen level in trees the week grass cover crop has become lower than the optimum. But as biannual cropping also is a factor in the yield levels a few more cropping years will answer this question.

The fruit size is equal for the 3 cover crops. The fruit quality measured as fruit colour and disease infections are better for the fruits grown at the lowest nitrogen level in the week grass mixture (table 2 and 3).

The annual cover crop has at higher level of nitrogen in leaves and soil. This influences the fruit quality in a negative way. The most serious consequent has been that the apple scab resistance caused by the single gene (Vf) has been broken down. The fruit were very damaged by apple scab in 1999. Table 4 shows the gradual break down of the scab resistance in the 10 varieties. The variety 'Florina' has other genes of resistance than Vf. The varieties 'Florina', 'Vanda', 'Retina' and 'Redfree' are still rather resistant.

Cultural techniques 1 and 2.

As the cover crop trial shows 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 have been planted in April 2001. The field plans are enclosed. The trees have been well established in very dense planting systems. Fresh new soil and mushroom compost were added in the plant hole to fertilise and prevent soil replant disease. Drip irrigation has been established. Establishment costs for one ha. are approximately 150.000 Danish crowns.

Due to problems buying identical plant material we had to establish one-year-old trees. The optimum would have been two-year-old trees. Therefore we decided to give the trees one-year of growth before we establish the fertiliser treatments.

C.2 Fulfilment of tasks and deadlines in individual work packages

WP number and title	Time schedule according to application	Deviations, if any*
WP 1: Early testing of new resistant selections.		
<i>Task</i>		
1 To find new resistant varieties suitable for the Danish climate through a close co-operation with the big breeding program in France		
<i>Deliverables</i>		
1. Agreement with INRA	2001	2002
2. Annual reports	2000, 2001, 2002, 2003	
3. National publication	2003	
4. International publication	2004	
<i>Milestones</i>		
1. Agreement with INRA about selection rights	2001	2002
2. Production of selection for screening very year		
3. Planting of selections in organic research area every year.		
4. Evaluation of selections every year.		
5. Promising selections propagated for test plantings at organic growers.	2003	
6. Planting of selections at organic growers.	2004	

Deviations are to be further discussed at C3

WP number and title	Time schedule according to application	Deviations, if any*
WP 2: Reducing apple scab infection risk using cultural methods.		
<i>Task</i>		
1. Reducing apple scab infection risk using cultural methods.		
<i>Deliverables</i>		
1. Annual reports	2000.2001, 2002, 2003 2004.	
2. Report about development of terminal buds in rootstocks.	April 2001	April 2002
3. National article about cover crop.	Marts 2002	
4. International publication about cover crop.	April 2003	
5. National article about cultural techniques.	Dec 2004	
6. International article about cultural techniques	Dec 2004	
<i>Milestones</i>		
1. Planting of new apple trial.	Winter: 2000-2001	
2. Analysing existing data about development of the terminal bud on different apple rootstocks.	Jan-April 2001	Jan-April 2002
3. National article about cover crops trial.	Marts 2002	
4. International article about cover crop trial.	April 2002	
5. Clearing of old cover crop trial.	2002	
6. National article about cultural techniques.	Dec. 2004	
7. International article about cultural techniques.	Dec. 2004	

• *Deviations are to be further discussed at C3*

C.3 Discussion on the progress, incl. deviations and achievements in the project as a whole and in the individual work packages and

As the collaboration agreement with INRA- France concerning variety agreement rights not yet is fully negotiated and thereby delayed I hereby apply for extension of WP 1: Early testing of new resistant selections with one year. WP 1 is hereby continuing in year 2005. The wished changes are shown in the following budget.

Due to an overload of work for the project leader in 2001 the report about development of terminal buds in rootstocks was not carried out. The report is going to be written in the beginning of 2002 by Marianne Bertelsen.

The achieved results from WP2 project 1. Cover crops are very satisfying and have lead to many talks and discussions.

D. Description of plans and future work in the project as a whole and in the work package (Including plans for publication and communication)

The future work is planed to follow the plans described in the wp's and in "C.2. Fulfilment of tasks and deadlines in individual work packages" see above.

E. Project publications

1. Articles in international, scientific journals with review procedures

Kühn, B.F. & Thybo, A.K., 2001. Sensory quality of scab-resistant apple cultivars. *Postharv. Biol. Tech.* 23, 41-50.

2. Presentations 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 Challenges. 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 Challenges. 16-17 October 2000.

3. 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.

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. Tang i økologisk frugtavl. *Frugt og Bær*. 11/2001, s. 296-297.

4. Other presentations at meetings, field days etc.

28-29 September. 2000. Dækkulturer til skurvresistente æblesorter. Nordisk forskermøde. Den norske landbohøjskole. HLP

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

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

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

15. January 2001. Foredrag om skurvresistente sorter ved distrikt Vests årsmøde, Helsingborg Sverige. MB.

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

14. Marts. 2001. Teaching organic apple growers at an in-service course at koldkærsgaard. HLP.

9. August. 2001. Open day for organic growers in the research area. HLP.

16. August 2001. Open day for interested traditional horticultural growers. HLP.

4. September 2001. Open day traditional apple growers. HLP.

F. Scientific education (ph.d. and post doc.), including visiting scientists and visits abroad

None

G. National and international co-operation**National**

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

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

John Hockenull and Marianne Bengtsson. Royal Veterinary and Agricultural University, Department of Plant Biology, Frederiksberg C, Denmark)

International co-operation

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

Yves Lesspinasse, INRA, France. Breeder of apple scab resistant varieties.

H. Possible elaboration of project and achieved results

I. See C 1. Annual description of main results and conclusions.