



Sustainable production systems for organic apple production

Organic apples are often sold for fresh consumption and therefore have to obtain high quality requirements. The fruits must obtain the right size and be undamaged without important infections of pest and diseases. Apple scab causes brown or black spots on the fruits and severe infections can result in fruits not suitable for consumption. This disease causes big reduction in yield and quality in organic production. Copper is an effective fungicide to control diseases and is used in organic apple production in some European countries. Copper has not been permitted in Denmark the last 10 years and the European Union wants to reject it from the list of pesticides permitted in organic production. To improve the quality and yield in organic apple production, it is important to find the best culture techniques. Combinations of cultivars, nitrogen availability, rootstocks and planting distances are tried to prevent or reduce apple scab infections.

The organism that most often causes damage on the skin of apples is apple scab. Apple scab causes brown or black spots on the fruits and severe infections can some years result in fruits not suitable for consumption. This disease causes big reduction in yield and quality in organic production.

The yield at growers not using copper for apple scab control is only 0-50 percent of a conventional yield depending on the cultivar and the year. In average, the yield reduction was 86 percent compared to conventional production. Many organic apple growers use organic allowed pesticides to try to control diseases. Cobber is an effective fungicide to control diseases and is used in organic apple production in some European countries. Copper has not been permitted in Denmark the last 10 years and the European Union wants to reject it from the list of pesticides permitted in organic production. The break down of the genetic resistance towards apple scab in newly bred cultivars has decreased the possibilities for an economical rentable organic apple production.

Methods to prevent apple scab

The most important method to prevent apple scab is to use genetic resistant apple cultivars or cultivars with less susceptibility to apple scab. Small, open rather slow growing apple trees reduce the possibilities for apple scab infections. A high level of available nitrogen in the soil causes increasing growth and an extended growth season. This gives better infection possibilities for apple scab. The increased level of nitrogen in the plants also causes a decrease in the content of phenols in plant tissue, which increases the possibility of growth for apple scab.



Mechanical weed cleaning in the tree row



To optimise organic apple production, the effect of combinations of fertilisation, rootstocks and planting distance on apple scab infection, yield and fruit quality has been investigated. The research has been carried out in cultivars with a low susceptibility but no resistance to apple scab. Control of apple scab has been carried out at big ascospore discharge periods. The warning program RIMpro has been used to predict these severe infection periods.

Effect of cover crop on fruit quality

The effect of cover crops on quality and yield of apples was investigated.

The following cover crops were established in the alleyways:

- 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*



*The same cultivar
"Retina" grown at
different nitrogen levels*

and *Trifolium resupinatum*, sown every year in July. The soil has been kept black from April to July. In the tree row, the soil was mechanically cleaned and the trial was kept unfertilised and unsprayed. Fruits produced on trees managed with a grass alleyway (1) had a lower nitrogen supply to the trees and obtained the best skin coloration. A lower nitrogen supply, especially during fruit development, resulted in more red fruits. The apple scab infections were more numerous on apples grown in the annual cover crop (3). This treatment

gave the largest nitrogen supply to the trees. Overall, the fruits from the grass alleyways (1) had the highest percentage of marketable fruits.

Even though the gross yield was bigger from trees grown in the annual cover crop (3), the crop of marketable fruits was at the same level from the two systems. The reason was a higher percentage of disease infections on fruits grown with a higher nitrogen supply (3). The cultivars Otava, Prima and Florina produced the biggest yields. Vanda had the biggest fruits. The resistance to apple scab was broken down in most cultivars. The cultivars: 'Florina', 'Vanda', 'Retina' and 'Redfree' were less infected by apple scab. Only Florina was still fully resistant during the experiment.

Development of end buds in apples

Apple scab, which winters in the woody parts of the apple tree as conidia, is physically close to the developing of new fruits and leaves in the spring. It is very important to reduce the possibility of apple scab wintering in branches and buds. Early end of vegetative growth and development of end buds in autumn will reduce the possibility of late infection in autumn and thereby reduce the risk of spring infections from conidia in woody plant parts. End bud development depends on the cultivar and the rootstock. To know the end bud development of different combinations of rootstock and cultivars would mean to be able to recommend the earliest end bud development combinations for organic productions

and thereby reduce the infection risks of apple scab from woody plant tissue in the spring.

End bud development of 51 rootstocks showed that rootstocks with high winter hardiness also had the earliest end bud development. MM106 is a rootstock with poor winter hardiness and the latest end bud development of the 51 rootstocks. This rootstock is in several countries quite recommended for organic production, but as a consequence of these results, it should not be recommended to organic apple production. Surprisingly, the very vigorous growing Swedish rootstock A2 had an early end bud development. This rootstock is a potential good choice for an organic apple orchard where big trees or a vigorous growth is necessary. The weak rootstock M9, which is recommended for high planting density intensive orchards had an early end bud development and is also for that reason suitable for organic apple production. The Russian rootstock B9 is also potentially suitable for organic production due to weak growth, high winter hardiness and early end bud development.

Intensively grown organic apples

In two big trials, the optimum level of nitrogen in the soil and plants in relation to the disease infection, fruit quality and yield, were investigated. The non-resistant varieties ‘Discovery’ and ‘Ingrid Marie’ were chosen. They can be infected by apple scab, but are recommended for organic production because they are less susceptible.

In 2004 and 2005, the fruit quality and yield are recorded. The fruit quality consists of both outer quality and inner quality. Outer qualities are fruit size, fruit colour and damages caused by pest and diseases on the fruit skin. Inner fruit quality is firmness and content of sugar and starch.

In the EU-project (QLIF), the sensory quality and content of phenols will be investigated in relation to the production methods and especially the nitrogen availability and planting density. Results of the projects will be used to optimise the recommendations for organic production.

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Publications and further information

See the project website:
www.darcof.dk/research/darcofi/i2.html
and the internet-archive: www.orgprints.org

