Lower nitrogen supply gave better fruit quality in organic apples.

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Abstract.
The use of scab resistant apple varieties is the best way to prevent infections of apple scab *(Venturia inaequalis)*. In 1995 the then 10 most promising resistant apple varieties for Denmark where planted at Research Centre Årslev, Denmark in an organic production system. Three different cover crops where established in the alleyways. Weed cleaning in the tree row was done mechanically and the trees were kept unfertilised.
The annual shoot growth, nutrients in leaf sample, mineralised nitrogen in soil, content of water in the upper 50 cm soil, fruit yield and fruit quality were assessed.
The best fruit quality due to colour, pest and disease damage was obtained in trees grown in permanent grass alley way system which gave a nitrogen supply in the lower end of the optimum range. The resistance to apple scab was broken in most varieties. The varieties: 'Florina', 'Vanda', 'Redfree' and 'Retina' were less infected by apple scab.

Introduction.
Organic growers estimated a yield reduction of at least 86 percent compared to conventional production in a questionnaire. The estimation was based on production of the most common conventional grown varieties. The main reason for this low productivity is lack of control methods against diseases and pests, especially apple scab (*Venturia inaequalis*) (Lindhard et. al 1998). In Denmark most organic pesticides are not registered. Copper has for example not been on the market for 7 years. The aim of this study was to increase the amount of quality fruit by using the best varieties and soil treatments in an unsprayed organic apple orchard.

Materials and methods.
In January 1995, the then 10 most promising resistant apple varieties for Denmark where planted in an organic production system at the Research Centre Årslev, Denmark at a planting distance of 3.30 x 1.60 m (1894 trees per ha.). The varieties were 'Delorina', 'Florina', 'Otava', 'Prima', 'Redfree', 'Retina', 'Rewena', 'Saturn', 'Vanda' and 'X6398'. Three different cover crops were established in the alleyways.

1. Grass: A permanent weak grass mixture of red fescue (*Festuca rubra*) and meadowgrass (*Poa pratensis*).
2. Clover grass: A permanent clover grass mixture consisting of white clover (*Trifolium repens*) and perennial ryegrass *(Lolium perénne)*..
3. Annual: An annual cover crop of Italian ryegrass *(Lolium multiflorum)* and Persian clover (*Trifolium resupinatum*) were sown every year in July and mulched in April the following year. Mechanical weed cleaning from April to July.

Weed cleaning in the tree row (1-meter width) was done mechanically and the trees were kept unfertilised and unsprayed.
The annual shoot growth, nutrients in leaf samples, mineralised nitrogen in the soil, content of water in the upper 50 cm soil, fruit yield and fruit quality were assessed every year.

Results and discussion.

Trees managed with an annual cover crop produced the highest gross yield, while the yield of the two permanent alleyway cover crops were at the same lower level (Table 1).

Fruits produced on trees managed with a grass alleyway and thereby a lower nitrogen supply to the tress obtained the best coloration. A lower nitrogen supply, during summer and resulted in more red fruits (Table 1). Oland (1960) also found this. 14.8 tons fruits form 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 were more numerous on apples grown in the clover grass and the annual cover crop. These treatments also gave the largest supply of nitrogen to the trees (table 1). This was the case although the level of total nitrogen in the leaves was within the optimum level for fruit production. The higher nitrogen supply resulted in a more vigorous growth and a denser tree, which gives a higher humidity in the crown, and thereby favours pathogen development. High nitrogen supply also reduces the phenolic synthesis in the trees and this increase susceptibility to apple scab infection (Buchter-Weisbrodt (1996).

The fruits were graded in marketable and discarded fruits on the basis of fruit size and 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 were at the same level for the three alleyway management systems due to different levels of pest attack (Table 1).

In 1996 no fruit were infected by apple scab, but in 1997 and 1998 few infections on fruits were observed. In 1999 more varieties became infected and the infections were more severe. The resistance to apple scab had broken down. The apple scab resistance origin from the V_f gene form *Malus floribunda* is overcomed by the new races 6 and 7 of *Venturia inaequalis.* Both races are present in Denmark (Bengtsson M., Lindhard H. and Grauslund J. 1999). At the end of the 2001 season only the variety 'Florina' remained free of scab, while 'Vanda', 'Redfree' and 'Retina' were still reasonable resistant to apple scab having less than 10 percent infected fruits. In the variety 'X6398' and 'Prima' the resistance was totally broken down (Fig 1).

Conclusion.

In an unsprayed organic apple orchard the best fruit quality due to colour, 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', 'Redfree' and 'Retina' were less infected by apple scab.

The resistance to apple scab was broken in most varieties

Literature.

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Table 1. Yield (tons/ha) in average of 6 years. Yield (ton/ha) and percent fruits with more than 75 pct. skin colour, average of 1999-2001. Percent fruits with skin damage caused by apple scab, nitrogen content in leaves (percent of dry matter) and marketable fruit due to fruit size and skin damage (tons/ha) for three cover crops, average of 10 varieties 1998-2001.

Treatment	*Yield 1996-2001*	*Yield 1999-2001*	*% fruits >75 pct colour 1999-2001*	*Apple Scab 1998-2001*	*Nitrogen* 1998-2001*	*Marketable fruit 1998-2001 Pct.*	*Marketable fruit 1998-2001 Tons/ha*
Grass	16.15 b	25.80 b	57.2 a	7.9 c	2.16 b	74.2 a	16.48 a
Clover Grass	16.46 b	25.34 b	34.5 b	20.0 b	2.57 a	70.1 b	15.42 a
Annual	18.78 a	28.69a	29.8 a	29.8 c	2.49 a	63.2 c	16.46 a

*Optimum level Nitrogen: 2.0-2.5. Values followed by the same letter in columns do not differ significantly at $p<0.05$