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## Low nitrogen manuring increased yield in high-density organic apple production

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Yield, fruit quality and infections of diseases are determined by many production factors in the orchard. Water and nutrition supply, the choice of rootstock, planting density and control of diseases and pest are decisive.



**Photo 1.** Inspection of high-density organic apple orchard.



**Photo 2.** Mechanical weed cleaning.

Earlier research showed that **low nitrogen supply** gave the best skin quality regarding color and disease infections in unsprayed apples planted with a planting density of 1900 trees per ha. In a subsequent study we tested whether this was also the case with high density planting systems with up to 5500 trees per ha.

### Planting systems

The effect of soil treatments in a one-meter wide tree row was investigated in the Danish apple cultivar Ingrid Marie. The trees were planted in spring 2002 with permanent grass alleyways of red fescue (*Festuca rubra*) and meadow grass (*Poa pratensis*). The treatments included:

- no weed control
- mechanical weed control
- mechanical weed control with 25 kg N supply
- mechanical weed control with 50 kg N supply

### Low nitrogen supply increased yield

Weed in the tree row competed much with the trees for nitrogen and water, compared to mechanic weed cleaning in the tree row (**Table 1**). The weeds caused a slower tree growth and reduced flower buds formation and thereby a low yield. The slow growth resulted a reduced infection of fruit tree canker (*Nectria galligena*) and small, strong colored fruits with reduced infections of

apple scab (*Venturia inaequalis*) and monilia (*Monilia fructigena*). This is shown in **Table 1**.

Nitrogen supply in the tree row given as 25 or 50 kg N dry poultry manure pellets in spring caused a stronger growth and an increased yield compared to no nitrogen supply (**Table 1**). There was no significant additive effect on yield or growth in response to supplying 50 kg nitrogen compared to 25 kg. In general, nitrogen supply increased infections of fruit tree canker (**Table 1**).

## Rootstocks

The rootstock M9 had the weakest growth measured as trunk diameter. The amount of pruned branches shows that pruning of the rootstock MM106 was most time consuming. The yield was not significantly affected by the rootstock in these young and relatively low yielding trees. MM106 produces the smallest fruits and had the smallest number of flowers in 2005 (**Table 2**).

The results show that during the first years of high-density plantings of Ingrid Marie the choice of rootstock was not decisive.

In similar research with rootstocks to the cultivar Discovery we concluded that the dwarfing growing rootstocks M9 and B9 had a higher yield efficiency, developed bigger fruits and cause fewer infections of fruit tree canker. For these reasons the dwarfing rootstocks were more suitable for organic production than the more vigorous rootstocks M26 and MM106.

Infestations of apple sawflies (*Hoplocampa testudinea*) caused severe reductions in yield. Sawflies have been a major pest in organic apple production in Denmark and other European countries for some years. However the fruit set in 2005 looks fine, probably due to our use of Quassia to control the larvae of apple sawflies just after flowering.

## Optimum planting distance is 0,9 m between the trees

A planting distance of 0,6 m between the trees in the row reduced vegetative growth measured as trunk diameter and weight of pruned material as compared to a distance of 0,9 m (**Table 3**). Thus, there is considerable competition for light, nutrition and water in the densest planting system.

The trees had the same level of available rainfall to share per ha. Thus, trees on a 1,2 m planting distance in the tree row had a higher supply of water per tree than trees on 0,6 m planting distance (**Table 3**). In a high density planting system water may more often become limited compared to systems with fewer trees per ha. Therefore irrigation systems are important in high-density plantings.

The competition for space caused fewer resources for flower bud formation and fruit growth (**Table 3**). But due to the higher number of trees per ha in the high-density system yield per ha was still slightly higher with 0,6 m between the trees in the tree row.

High-density orchards are expensive to establish, because expenses for trees are high. In this trial, a yield reduction per tree occurred for the densest planting distance already after the first two yielding seasons. Thus, it is not likely that the high density of 5555 trees per ha is profitable in the long run.

## Conclusion

- Weeds in the tree row reduced yield significantly
- Slow growth reduced fruit size, increased skin color, and lowered infections of fruit tree canker, apple scab and monilia

- Mechanical weed cleaning in the tree row and manuring with 25 kg N in spring increased yield compared to no manuring
- Manuring with 50 kg N did not give further advantages
- The choice of rootstock did not affect the yield the first two years for Ingrid Marie
- High-density plantings requires water supply
- Planting density in the tree row should not be closer than 0,9 m for Ingrid Marie on M9.

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