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Soil treatments and rootstocks for organic apple production

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The apple variety 'Retina' is recommended for organic production in Denmark. Yet, there is no knowledge regarding the optimal rootstock for this variety. Better knowledge is also needed on production techniques, such as weed control, where different machinery for mechanical weeding is available. Therefore, we tested the combined effect of different rootstocks and weeding techniques including soil covering with straw. As organic growers discus the necessity of weed cleaning at all, the natural vegetation was used as control treatment in the trials.

Rootstocks and soil treatments

The German apple variety 'Retina' from Dresden-Pillnitz is an early variety with harvest in the first week of September. 'Retina' generally has a good overall resistance to apple scab even though the Vf resistance was broken.

One-year-old 'Retina' was planted in the winter 1997/1998 at Fejø Research Orchard, Denmark, at a planting distance of 3.5 by 1.5 m (1732 trees/ha) and white clover grass was established in the alleyways. 'Retina' was grafted on the three rootstocks M9, J9 and M26 and six soil treatments were established in a 1-m wide strip in the tree row:

1. Mechanical weeding also in the alleyway, using a Humus cultivator (a rotary cultivar with hooks) 4-6 time each season
2. Mechanical weeding in the tree row using a Clemens cultivator (a tractor driven Dutch hoe) 4-6 times each season
3. Mechanical weeding in the tree row using a Humus cultivator 4-6 times each season
4. Mechanical weeding in the tree row using a dish harrow 3-5 times each year

5. Soil covering with 15 cm of wheat straw in the tree row renewed every 2nd year. The straw was removed around the stem basis and 1 litre of crushed seashells was placed around the stem every year to prevent mice damage

6. Natural vegetation in the tree row, cut down in June and end of August every season.

Every spring the trees were hand-hoed around the trunk. The trees were supplied with 25 kg nitrogen per ha coming from slurry every spring and 1½-2 litre water per tree from drip irrigation daily in the growing season.

The trees were sprayed with 4 kg elementary sulphur 1-4 times per year in 2001-2003 at primary RIMpro warnings to prevent the breakdown of the apple scab resistance (Vf) of 'Retina'.

Vegetative growth

Natural vegetation in the tree row reduced the vegetative growth and weight of pruned material. Mechanical weed cleaning also in the alleyway (Treatment 1) and mechanical cleaning in the tree row using Humus (Treatment 3) produced the largest vegetative growth. The rootstock M26 had the most vigorous growth, whereas M9 had a slightly smaller growth than J9. No differences in mildew infection occurred on annual shoots due to rootstocks or soil treatments. In general the mildew infections were high, 70-80 percent of the shoots had small infections and 10-20 percent shoots had severe infections.

The content of total nitrogen in the leaves varied from higher than the optimum range (2.0-2.5 percent nitrogen of dry matter in leaf samples) to just lower than recommended. Natural vegetation in the tree row gave the lowest nitrogen content in the leaves. There were no significant differences between the other treatments.

Yields

The year 2000 was the first cropping year. Until 2002 the yields were similar for the two rootstocks M9 and J9, but in 2003 J9 had the highest yield.

M26 gave in total a 13-16 t/ha smaller crop yield over the period (Figure 1). The rootstock M26 gave the best yield if grown in a soil treatment, where the clover grass alleyways were weeded. The competition for water and nutrients between the clover grass and the rootstock M26 probably reduced the yielding potential for M26 even though the vegetative growth still was higher than for M9 and J9.

Trees grown in natural vegetation (weed) in the tree row obtained for all rootstocks the lowest yield (Figure 1) and the smallest fruits. Mechanical cleaning also in the alleyway resulted in the highest crop yield for all rootstocks. Until 2003

soil covering with straw was at the same level as mechanic cleaning in the tree row, but in 2003 the yield on trees grown in soil covered with straw were at the same level as trees grown in soil with mechanical cleaning also in the alleyway. Straw decreases the potential water evaporation from the soil surface. Even in this trial, where we used drip irrigation the water savings using soil covering with straw had an additional effect on increasing growth and yield. We had no problems with mice, due to use of seashells around the stem in winter.

Weed cleaning using dish harrow resulted in the lowest yield of the five treatments, where weeds were controlled (Figure 1). The machinery was not satisfying compared to the other equipments as weed cleaning up to one month before harvest had to be avoided due to risk of damaging low-hanging fruits.

Pest infestation

Grading the harvested fruit according to fruit size and skin damages showed no significant differences between soil treatments and rootstocks. The fruits were highly infested with pests: tortrix (19%), codling moth (12%), apple sawfly (31%) and red apple aphid (11%). Also, there was a break down of the apple scab (Vf) resistance of 'Retina', especially in the most vigorous growing trees. As a consequence, the percentage of marketable fruits was as low as 52-70 % in 2003. In this context it should be noted that, in Denmark, nearly no pesticides are allowed in organic production to control pest and diseases. And the price per kg sold fruit is normally around 1.3 Euro when costs for packaging and storage are paid.

Conclusions

- The rootstock J9 had the highest yield and the biggest amount marketable fruit of 'Retina'.
- Mechanical cleaning also in the alleyway (Treatment 1), tree row weed control using a Humus cultivator (Treatment 3, 2003) or soil covering with straw (Treatment 5) gave the largest yield and ton marketable fruit for organically grown 'Retina'.
- A 1-m weeded strip in the tree row did not remove the competition from the clover grass alleyway.
- Natural vegetation in the tree row reduced the yield with more than 50 percent.

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