Combined production of broilers and fruits

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Abstract
Combined production of broilers and fruit trees is a subject often discussed in organic fruit production in Denmark. Very little research has been carried out on this type of production system. In organic production in Denmark, nearly no pesticides are allowed, so the need for alternative pest control is large. Apple sawfly (*Hoplocampa testudinea*) and pear midge (*Contarinia pyrivora*) cause big crop losses in apples and pears respectively, in unsprayed organic fruit production. Both insects infest fruitlets and cause these to drop prematurely after which the pests pupate in the topsoil. In the present experiment a research orchard with the varieties 'Discovery' and 'Conference' were used as outdoor area for broilers to minimise the population of sawflies and pear midges, and to reduce the need for weeding and manuring. The trees were kept unsprayed. Fruit yield and fruit quality were assessed at harvest. White sticky traps were placed in the test area in order to measure the occurrence of sawfly over time. The infestation of pear midge was investigated counting the infested fruitlets in clusters on trees at the centre of the plots. The catch of apple sawflies was reduced in the combined apple and broiler production, but no significant effect on the yield or the fruit quality was seen. Experiences from on-farm research show that combining fruit and egg-production is one way to reduce the problem with apple sawfly, but poultry alone is not a sufficient way of controlling sawflies. The welfare and health of the broilers were excellent under fruit trees.

Keywords
Organic, apple, pear Apple sawfly (Hoplocampa testudinea), pear midge (Contarinia pyrivora), yield, fruit quality, animal welfare .

Introduction
Combined production of broilers and fruit trees are a subject often discussed in organic fruit production in Denmark (Lindhard Pedersen et al, 2002). Very little research has been carried out on this type of production system. In organic production in Denmark, no pesticides are allowed. The need for alternative pest control is therefore large. Apple sawfly (*Hoplocampa testudinea*) and pear midge (*Contarinia pyrivora*) cause big crop losses in apples and pears respectively. Both insects infest fruitlets and cause these to drop prematurely after which the pests pupate in the topsoil. The use of Neem or Quassia-products is not allowed. Some organic top fruit producers have experience with fruit production in combination with poultry.
Gallinaceous birds originally lived in forests where they can hide for predatory birds under bushes and trees. Living in fruit orchards are close to their original environment. The welfare of broilers will probably be better in an orchard than on a grass land, where they normally are produced.

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In a small-scale trial the hypothesis of reduction in apple sawfly and pear midge populations and infestation due to pupate and fruitlets feed of broilers was tested. Also the effect of broilers on weeding, fertilisation, yield and fruit quality is investigated.

Materials and methods

The apple variety 'Discovery' is susceptible to apple sawflies, but is recommended for organic production because it is less susceptible to diseases. The pear variety 'Conference' is recommended for organic growing because it is highly pear scab resistant. 'Discovery' was grafted on rootstock MM106, the planting distance was 3.25 x 1.25 m. and 'Conference' was grafted on quince A, the planting distance was 3.5 x 1.4 m. and drip irrigated was established in autumn 1997 at Fejø, research orchard, Denmark. Chicken runs with a width of 5 rows and lengths of 10 trees were established spring 2002. A total of 18 plots were used with and without release of broilers. The trees were kept unsprayed. Mechanical weeding in the tree row was done just before and after the release of broilers. The no of flower cluster, fruit yield, marketable fruits and fruit quality evaluated as skin colour and damages cased by pest and diseases were assessed on single fruits from six trees per plot.

White sticky traps (Rebell bianco®) were placed in the test area. One trap was placed in each plot, from late April to beginning af June 2002 and 2003. The sticky traps were changed weekly. The infestation of pear midge was investigated counting the infested fruitlets in clusters on trees at the centre of the plots 2002. In June 2003 the drop of fruitlets due to sawfly and pear midge from trees in the centre of the plots was counted weekly.

In Denmark the most common commercial breed in organic broiler production is Scan Labelle, strain "I 657". In 2002 we compared I 657 (n=196) to the French breed LaBresse (n=216). LaBresse was reared together with I 657 the first five weeks at an organic producer of fruit and broilers. The broilers were given access to an orchard at 8 m^2 per broiler and unlimited access to feed and water, when moved to the experimental orchard at five weeks of age.

In 2003 we compared I 657 (n=150) to two pure breeds, Light Sussex (n=148) and New Hampshire (n=148). They were fed a concentrate with 16% protein ad lib, when moved to the Experimental orchard at the age of five weeks.

. This is a little less compared to the normally used starting and growing feed for organic broiler chickens. We used concentrate with less protein since the chickens had access to protein feedstuffs in the shape of insects, larvae and clover grass. Half of the chickens was slaughtered at 91 days of age and half was slaughtered at 120 days of age.

Results

The yield of 'Discovery' in 2002 and 2003 and 'Conference' in 2002 was very small, showing the severity of the crop loss due to apple sawfly and pear midge in unsprayed organic fruit production (Table 1 and 2).

The flight of the sawflies started the first week of May both years. The most intensive flying period was mid May and no sawflies were caught after the end of May (Fig 1 and 2).

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A reduced catch of sawflies were found on sticky traps in chicken runs (Fig 1). The number of caught sawflies was reduced by 50-75 percent in treatments with broilers in 2002 and 10-25 percent in 2003.

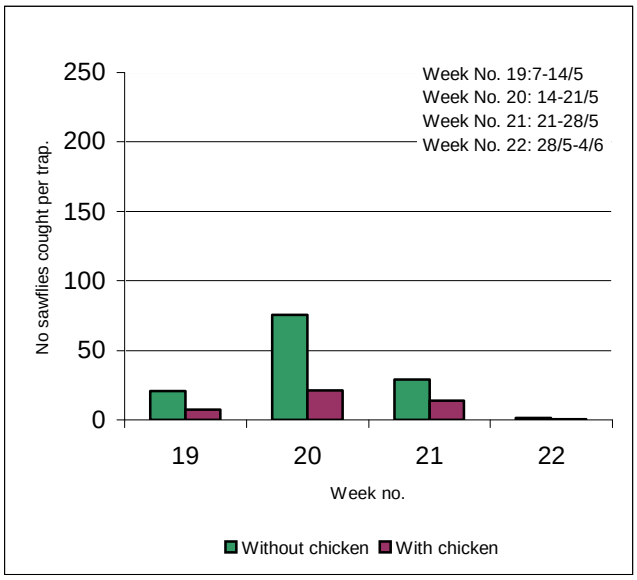

Fig 1. Weekly catch of apple sawflies on sticky traps, May 2002.

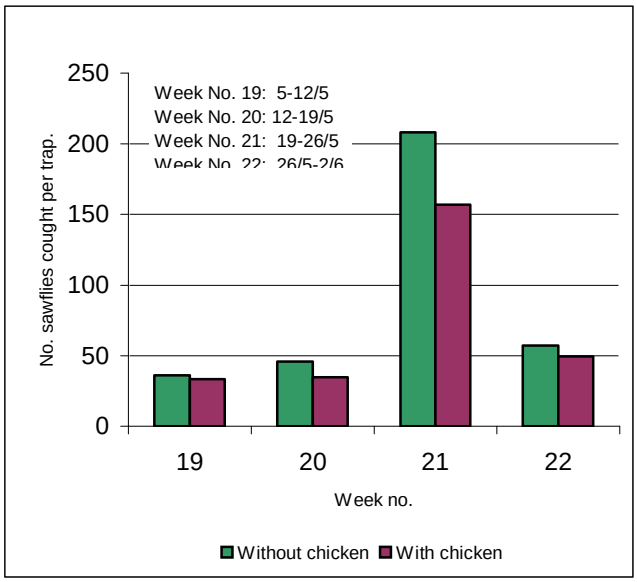

Fig 2. Weekly catch of apple sawflies on sticky traps, May 2003.

The yield and fruit size (not shown) in Discovery was alike for the two treatments in 2002 and 2003 (Table 1). The total numbers of flower clusters and there by the potential yield in 2003 was the same for the two treatments even there was a tendency towards a higher number of flower clusters on the trees grown in combination with broiler. The harvested fruit per cluster was very low and the number of drop of fruitlets due to infestation of sawflies was very high (table 1). There was a tendency towards a bigger drop of fruitlets from trees grown without broilers.
Skin damages caused by infestation of pests and diseases (not shown) on the skin of harvested fruits did not differ for the two treatments (Table 1).

Table 1. Yield (Kg/tree) 2002 and 2003, flower cluster 2003 (no/tree), harvested fruits per cluster 2003, fruit drop due to infestation of apple sawfly per cluster (no/tree), percent fruits with skin damage caused by tortrix, codling moth and apple sawfly in 2002-2003 for the apple variety 'Discovery' produced with and without broilers.

Treatments	Yield 2002	Yield 2003	Flower cluster 2003	Fruits per cluster 2003	Sawfly infested fruit drop Per cluster 2003	Tortrix	Codling moth	Apple sawfly
No broilers	1,1 a	0,9 a	133 a	0,06 a	0,643 a	25,9 a	8,3 a	17,3 a
Broilers	1,1 a	0,4 a	156 a	0,02 a	0,514 a	24,0 a	7,4 a	15.2 a

Values followed by the same letter in columns do not differ significantly.

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The fruit yield in 'Conference' was very low in 2002 and acceptable in 2003. The low yield in 2002 was probably due to the high number of fruitlets infested by pear midge (Table 2). The total numbers of flower clusters and thereby the potential yield in 2003 was the same for the two treatments even there was a tendency towards a higher number on the trees grown in combination with broilers. The harvested fruit per cluster was low and the number of drop of fruitlets due to infestation of pear midge was very low (table 2). The low yield in 2003 was probably not caused by pear midge, as the number of infested fruitlets was very low. The infection of pear scab was high, but did not influence the fruit shape. Skin damages caused by infestation of pear midge and capsids on the harvested fruits were reduced for fruits grown in combination with broilers (Table 2).

Table 2. Yield (Kg/tree) 2002, percent midge infested fruitlets May 2002, Yield (kg/tree) 2003, fruit size 2003 (g/fruit), flower cluster 2003 (no/tree), harvested fruits per cluster 2003, fruit drop due to infestation of pear midge per cluster (no/tree), percent fruits with skin damage caused by apple scab, tortrix, capsids and pear midge in 2003 for the pear variety 'Conference' produced with and without broilers.

Treatments	Yield 2002	Infested fruitlets 2002	Yield 2003	Fruit size 2003	Flower cluster 2003	Fruits per cluster 2003	Fruit drop per cluster 2003	% apple scab 2003	% Tortrix 2003	% Capsids 2003	% pear midge 2003
No broilers	0,53 a	24 b	3,35 a	168 b	43,4 a	0,48 a	0,015 a	95,9 a	6,8 a	4,1 a	2,7 a
Broilers	0,61 a	46 a	3,30 a	192 a	52,7 a	0,34 b	0,013 a	97,2 a	7,3 a	0,0 b	0,0 b

Values followed by the same letter in columns do not differ significantly.

Feed consumption of the Scan Labelle, strain I 657 was in 2002 calculated to 179 g of concentrates per broiler daily, which seems very high. Differences in final weights are shown in table 3. I 657 was slightly older (97 days) compared to LaBresse (92 days) at the day of slaughter, but there is anyhow no doubt that I 657 gets bigger than LaBresse under the same conditions.
In 2003 the feed consumption (additional feed) per kg gain did not increase with increasing age and live-weight, and the live-weight gain and the daily gain in the last 30 days was not very different among genotypes (Table 3).

Table 3. Age at slagther (days), Live-weight (g), Average daily gain (g) and feed comsumption (g/broiler/day) for two broiler breed in 2002 and 3 broiler breed at two slaughter ages in 2003.

Breed /year	I 657 (2002)	LaBresse (2002)	I 657 (2003)	Light Sussex (2003)	New Hampshire (2003)	I 657 (2003)	Light Sussex (2003)	New Hampshire (2003)
Age at slaughter.	97	92	91	91	91	120	120	120
Live-weight.	2766	2214	2267	1589	1501	2908	2232	2050
Daily gain.	29	24	25	17	16	24	19	17
Feed consumption.	179		111			112		

Overall the welfare and health of the broilers seemed to be excellent. Welfare assessment of 80 birds in 2002 and 422 birds in 2003 showed no problems with the plumage condition and foot health and no broilers had skin lesions. Only 1 had serious keel bone deviation. We didn't find any type of salmonella. 24 chickens were killed by birds of prey and 6 died

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as a consequence of transport or because they were caught in the fence. No chickens died because of illness or other welfare problems.
Experiences from on-farm research projects concerning layers in apple orchards showed the weeding and reduction of insects is evident within a 100 m from the house. The effect decreases with the distance from the henhouse. Apple sawfly were found in 20% of the apples situated within 100 m from the henhouse, but in 75% of the apples situated further away. A similar effect was seen on Pear midge.
The trees were higher fertilized close to the house, app. up till 50 m from the house. The level of nitrogen is, although high, still within the recommended range for apples. It is necessary to protect the trunks of young trees against pecking from the layers.

Discussion
Experimental designs concerning production systems trials are a challenge, especially when effects on mowing factors like insect populations are investigated. Designing trials take into considerations the soil and micro climatically variations, the economical liberty of action and the biological and practical factors. In this trial we decided to put 5 chicken runs for Discovery and Conference respectively, to eliminate the block variation. The rather small plots sizes reduced the chance to determine any variations in the sawfly and pear midge population, in spite of that, we found a difference in the caught of sawflies on sticky traps, which was very satisfying. When egg layers are combined with apple orchards the on-farm research showed a reduction on sawfly and pear midge infestation in the fruits decreasing with the distance from the henhouse. Together the results show that combined production of apples and broilers or egg layers can have a decreasing effect on the population of apple sawflies.
The population size of apple sawflies at the research orchard was very high in 2002 and 2003. In susceptible varieties a total caught of 20-30 sawflies per sticky trap is the damage threshold (Graf et al 1996), The overall population was still large enough the destroy most of the Discovery harvest. The reduced caught of apple sawflies had no significant effect on the yield or the fruit quality (Table 1).
The rules for organic broiler production require a slow-growing breed i.e. broiler chickens are slaughtered at the age of 81 days earliest and the average daily weight gain must not exceed 30g. The chickens are however also wished as controller of weed and pests in the orchard. For this reason it is desirable to keep the chickens a little longer in the orchard although the feed consumption might increase. Moreover it has been demonstrated that fast growing broilers will not be as active in an outdoor area as a slower growing breed (Thomsen, et al., 2001).
Observation in the orchard in 2002 showed that LaBresse was a little more active compared to Scan Labelle, I 657, but further investigation is needed.
The broilers were fed with less protein during the first 5 weeks in 2003. For that reason these chickens were a little smaller compared to the 2002-flock when releases in the orchard. Observations however suggest that they were more active compared to the 2002-flock since they used the entire outdoor area and only rarely stayed inside the chicken house. There was a tendency towards the Light Sussex breed was the most active of the

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three genotypes in 2003. It was interesting that feed consumption (Table 3.) was considerable lower compared to the 2002-flock.
The experiment demonstrated that a reduced population of apple saw flies and good animal welfare could be obtained when broilers were reared in an orchard.

Conclusion

1. Apple sawflies and pear midge cause big losses in unsprayed organic fruit production.
2. The catch of apple sawflies was reduced in the combined apple and broiler production.
3. The reduced catch of apple sawflies had no significant effect on the yield or the fruit quality.
4. Experiences from on-farm research shows that combining fruit and egg-production is one way to reduce the problem with apple sawfly. But poultry alone is not a sufficient way of controlling sawflies.
5. Broiler production under pear trees did not affect the yield.
6. Skin damages on harvested pears may be reduced in production combined with broilers.
7. The welfare and health of the broilers were excellent under fruit trees.

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