

## Optimizing crop loading of apples and pears - results 2004-2006 (foliar fertilizers, thinning)

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### Abstract

*Main topics of the research-project FuE 03OE088 of "Bundesprogramm Ökologischer Landbau" (30.04.2004-31.12.2006) were the testing of foliar fertilizers in organic apples and pears, optimizing lime sulphur for blossom thinning, looking for alternatives to lime sulphur for blossom thinning and looking at different combinations of thinning measures. Only the results of testing foliar fertilizers (carried out by KoGa Ahrweiler and OVB/ÖON Jork) and combinations of thinning measures (carried out by LVWO Weinsberg) are described in this article. Over three years only a small increase in yield was evaluated for the fertilizers Aminosol PS and Wuxal Ascofol (site Ahrweiler, apple variety 'Elstar'). In Jork (apple variety 'Holsteiner Cox') yield could only be judged in 2005 and 2006. Wuxal Ascofol showed some advantage in comparison to the control. At pear variety 'Conference' no clear tendencies could be seen, the control had the highest yield. In 2005 the fruit-setting of 'Conference' was very low because of bad conditions during blossom.*

*All combinations, which consisted of two thinning measures, balanced the crop loading of 'Elstar' (organic orchard near LVWO Weinsberg) in a way, that in spring 2007 the setting of blossom clusters was clearly higher than in the control, so alternate bearing could be reduced. The best effects had thinning strategies, that included blossom thinning (2 x 30 l/ha lime sulphur). Less time was necessary for thinning by hand, when additional pruning was done (169 h/ha thinning by hand - only by hand 255 h/ha) or when blossom spraying was performed (101 h/ha left for thinning by hand).*

**Keywords:** thinning, foliar fertilizers, apples, pears, organic orchards

### Introduction

In spring 2004 a research project granted by the "Bundesprogramm Ökologischer Landbau" (FuE 03OE088) started with the aim to test different possibilities to increase fruit setting of apples and pears by using foliar fertilizers on one hand and to reduce an overloading crop on alternate bearing apple varieties by additional pruning in spring or by blossom sprayings on the other. The selection of the tested foliar fertilizers based on results from Renner (2002), Ruess & Belz (2003) and on experiences of organic fruit growers. Within blossom thinning different application doses of lime sulphur (variety 'Elstar') and possible alternatives to lime sulphur were tested at the varieties 'Gala' or 'Elstar'. The results of this trials were described detailed in the final research-report (Eis & Pfeiffer, 2008). In the following the most important results of the foliar fertilizer experiment and of a trial about combinations of different thinning measures shall be discussed.

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## Material and Methods

**Experiment 1 (foliar fertilizers)** consisted of three trials. The Kompetenzzentrum Gartenbau in Ahrweiler (near Bonn) tested on an organic orchard BIOFA Algenextrakt (5 l/ha), Wuxal Ascofol (3 l/ha), Aminosol PS (5l/ha), bitter salt (7 kg) and a combination of LEBOSOL Zink & LEBOSOL Mangan (varying doses depending from stage of tree) at the apple variety 'Elstar' and at the pear variety 'Conference'. Each fertilizer was sprayed on 4 x 7 trees. In every year 3 applications were done around blooming time, for the treatment Zn+Mn one additional application followed after harvest. Yield (kg/tree), average fruit weight, fruit size grading, percentage of red colour and russetting of the fruits were evaluated on apples, on pears only yield and fruit size grading. A similar trial with the same variants (4 x 6 trees per variant) was carried out by the ÖON/OVB Jork (near Hamburg) in an organic orchard at the variety 'Holsteiner Cox'. Here the treatment Zn+Mn was replaced with Kaliumsulfat. Because of heavy attack of *Dysaphis plantaginea* the yield in 2004 could not be evaluated, so data were assessed from 2005 and 2006.

In **experiment 2** the effect of different combinations of **thinning measures** on the amount of time needed for thinning by hand, yield, average fruit weight, size-grading and percentage of red colour was evaluated. The trial was carried out at over 15 years old, organic grown trees of 'Elstar' (10 trees per treatment, each tree was counted as replication). At first trees with a high number of blossom buds were selected for the trial. At these trees the normal winter pruning was done following the remark of the farmer that winter pruning should not last longer than 50-60 h/ha. Afterwards the first measure "additional pruning" to reduce the number of branches with lots of blossom buds was carried out. For this work a limit of about 18-20 h/ha was set. Single branches and parts of the trees with lots of spurs were removed. In spring 2006 between 350 and 500 blossom clusters/tree were counted on the about 2,5 m high trees. For "Blossom thinning" lime sulphur (30 l/ha) was sprayed with a portable Solo-Sprayer (air-supported) at beginning and at full blossom. "Hand thinning" was done on May 31<sup>st</sup> 2006 before June drop, time necessary for that step was stopped for each tree separately. These three measures were combined in different ways (see table 1).

Table 1: Combination of thinning measure at the variety 'Elstar' 2006

Treatment	Abbreviation (in figures)	additional pruning	blossom thinning	hand thinning
1	Con			
2	H			<b>X</b>
3	add. Pr.	<b>X</b>		
4	add. Pr.+H	<b>X</b>		<b>X</b>
5	add. Pr.+B	<b>X</b>	<b>X</b>	
6	add. Pr.+B+H	<b>X</b>		<b>X</b>
7	B		<b>X</b>	
8	B+H		<b>X</b>	<b>X</b>

The evaluations were focussed mainly on the following points:

- How much time is necessary for the different strategies
- Are there improvements in fruit-weight, size-grading and colour of the fruits?
- Which strategy has the best potential to break alternate bearing in a sufficient way?

In December 2006 the percentage of blossom and leaf buds was evaluated under binocular (Baab, 1988) to see, if the measures had success to break alternate bearing. Finally the number of blossom clusters/tree were counted in April 2007 to check the tendencies from bud-analysis.

## Results

Between the **foliar fertilizers** tested in experiment 1 (variety 'Elstar') Aminosol PS showed the highest yield with 11,58 kg/tree (average per year, data from 2004-2006). The second best result was found at Wuxal Ascofol (11,71 kg/tree\*year) in comparison to control variant (10,96 kg/tree\*year). The other treatments had the same level as the control or a little bit lower (Eis, Pfeiffer, Zimmer & Fieger-Metag, 2008). Treatments with a high total yield had also the most apples in size 65-85 mm. Some fruits showed more russeting, but it was not clear, if there were interactions with the plant protecting strategy against scab. Under the conditions in Northern Germany only the foliar fertilizer Wuxal Ascofol (22,6 kg/tree and year, average from 2005+2006) increased the yield of 'Holsteiner Cox' in comparison to control (20,3 kg/tree\*year). The average fruit weight mainly was influenced by the intensity of crop loading of each treatment.

In the field trial with the pear variety 'Conference' in the year 2005 yield was very low because of bad weather conditions during pear blossom time (less than 1,5 kg/tree). The total yield (average from years 2004-2006) was highest in the control (10,13 kg/tree\*year), followed closely by the other variants except for bitter salt (only 8,3 kg/tree\*year), the reason for that bad result was not clear. Size grading was very similar within all variants with the highest peak in size 65-70 mm.

In experiment 2 (**combining of thinning measures**) the fruit setting on the control-trees at the end of May was about 1 apple/blossom cluster, in the treatments with hand thinning the fruit setting was reduced to 0,6 apples/blossom cluster. During summer even in the not thinned control many fruits dropped down because of cold temperature in the night and less bees flying during blossom, so at harvest only 0,2-0,3 apples/cluster were counted at trees without hand thinning.

Figure 1 shows the requisite time (hours/ha) for different thinning strategies (except for 2,5 h/ha for thinning spraying at blossom) in view of the following facts:

- in this orchard about 1900 trees/ha were planted, the trees were very vigorous
- As result of assessments of flowering intensity in alternate bearing varieties it was assumed, that only 70 % of the trees per ha have so much blossoms, that strong thinning measures like the tested ones are necessary

Lots of hours were necessary at the trees, where thinning was done only by hand. In some treatments (add. Pr., add. Pr.+B, B) no apples were thinned by hand. Additional pruning lasted only 12-16 h/ha and reduced time for thinning by hand to 170 h/ha. At the combination “additional pruning + blossom thinning” only about 100 h/ha were left for thinning by hand. The combination “additional pruning + blossom thinning + hand” had the lowest requisite time in the measure “thinning by hand” (65 h/ha). During summer natural fruit drop was relatively high, so finally at harvest this strategy had thinned too heavy (see data about total yield).

**Requisite time (h/ha) for combinations of different thinning measures at 'Elstar'**

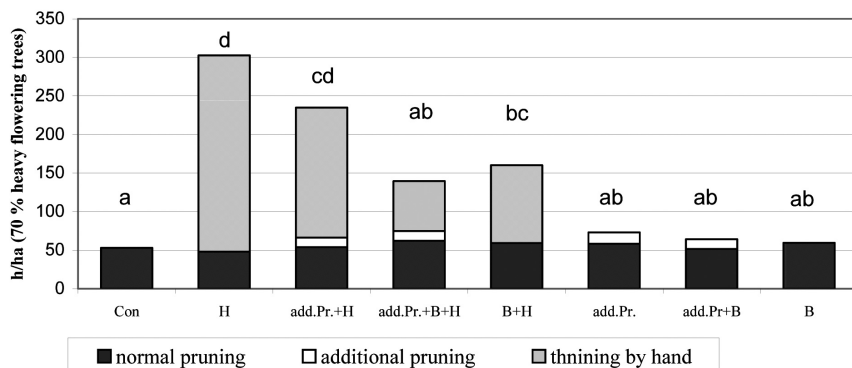


Figure 1: requisite time (h/ha) for combinations of different thinning measures at 'Elstar', for variants with “B” about 2,5 h/ha must be added for blossom sprayings, control without any thinning, Tukey-test,  $\alpha=0,05$  for total requisite time

In the not thinned control about 190 apples/tree were left in autumn, at the first picking in all variants about 6-7 kg/tree were harvested. How many apples were harvested at the second and the third time was influenced by the success of thinning strategy (See table 2). The average fruit weight in the control was 150 g. All apples of 10 trees per treatment were sorted with an AWETA size-grading machine as one unit. Figure 2 shows the total yield per tree, divided in three grades (excellent coloured + good size, well coloured + good size, green + small).

As expected the highest yield was evaluated for the not thinned control, but 5,72 kg/tree were too green or too small. In this organic orchard the plant density was about 1900 trees/ha, so between 15 and 20 kg unsorted apples/tree still met 28,5 to 38 t/ha. By the different thinning strategies the part of the lowest quality grade (too small and green) decreased.

Table 2: total yield, kg, 2<sup>nd</sup> and 3<sup>rd</sup> picking, average fruit weight ,g, (significances following tukey-test,  $\alpha = 0,05$ ), % flower-buds in December 2006

Variant	total yield kg/tree	2 <sup>nd</sup> picking kg/tree	3 <sup>rd</sup> picking kg/tree	average fruit weight (g)	% flower-buds Dec. 06
Con	28,72	7,93	13,52	155 ab	31
H	26,80	9,05	10,66	146 a	34
add. Pr.	18,33	8,43	4,36	162 ab	<b>53</b>
add. Pr.+H	19,92	6,54	7,27	170 b	<b>55</b>
add. Pr.+B	14,08	5,02	<b>2,32</b>	157 ab	<b>51</b>
add. Pr.+B+H	9,72	2,87	<b>2,78</b>	150 a	67
B	19,11	6,52	6,38	153 ab	<b>49</b>
B+H	19,30	6,43	5,16	154 ab	<b>52</b>

### Quality grades at 'Elstar' as reaction on combinations of thinning measures 2006

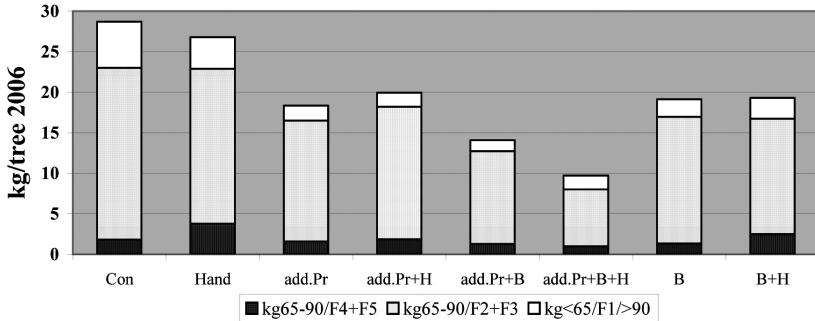


Figure 2: Total yield (kg/tree) of 'Elstar' 2006, divided in three quality grades (small + green, well coloured + good size, excellent coloured + good size), plant density 1900 trees/ha.

Bud-analysis in December 2006 allowed a good forecasting of flowering-intensity in spring 2007 as shown in figure 3. Hand thinning had less success in breaking alternate bearing, even if it was done early, and showed a large variation. Additional pruning as a simple measure had some effects. If a fruit-grower is not allowed or is not willing to use lime sulfur for blossom thinning, this might be a possible solution. Clearly all combinations including blossom thinning with lime sulfur ( $2 \times 30$  l/ha) had the strongest effect on alternate bearing. These trees had about 180 to 225 blossom-clusters more than the control in spring 2007.

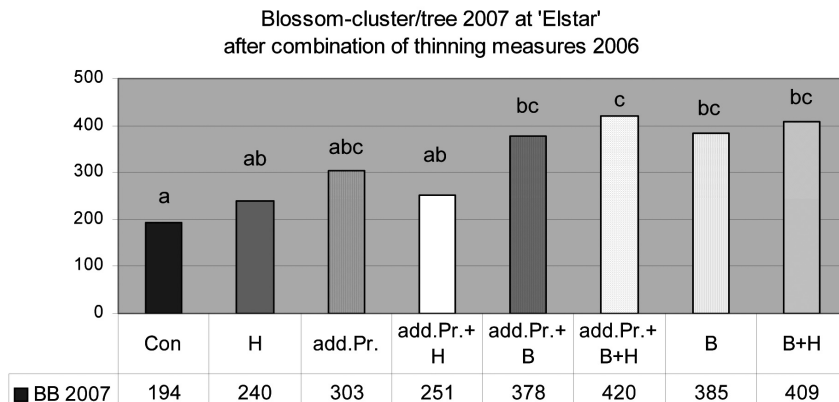


Figure 3: Number of blossom-cluster/tree in 2007 at 'Elstar' after thinning measures 2006 (Tukey-test,  $\alpha = 0,05$ )

### Summary experiment 2

Blossom thinning and additional pruning had success in reducing time needed for thinning by hand, the yield was lower than in control (about 7 kg/tree less in acceptable quality) and less too small and green apples were harvested. This lower yield was compensated by a higher setting of blossom clusters in the next spring 2007, which led to an estimated higher yield of about 10 kg/tree (180 blossom-clusters more per tree x 0,4 apples/cluster x 140 g/apple), while the yield of the not thinned trees of the control was low. The aim of partly reducing alternate bearing could be reached in this trial. Even one year later the trees with additional pruning showed a clear difference in the growing characteristics (better balance between crop loading and growth increment).

### Acknowledgements

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