Towards Grower-friendly Apple Crop Thinning by Tree Shading

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Abstract

Light management with shading nets, which reduce sunlight by 74%, might be an alternative to chemicals commonly used for thinning on apple trees. To study the effect of shading on crop load and fruit quality, trials were conducted in field experiments with the cultivars Golden Delicious and Elstar in 2006. Trees were either covered 25 days after full bloom (DAFB) with a net during three days, or until the peak of fruit fall, observed after seven days shading. Ideal time length for optimal crop yield was seven days shading for Elstar and three days shading for Golden Delicious. Alternate bearing could be decreased as flower initiation counts the following year showed. In both experiments, inner quality of fruit such as sugar and firmness showed good values at optimal shading duration compared with chemical + hand thinning. In 2007, a second field trial was conducted with cultivars Golden Delicious and Topaz to study the time period for shading in further detail. Shading was done for three days at 19, 26 and 33 DAFB using two net types (three- and two-meter-net width, covering the trees entirely or only down to 50 cm above ground). For Golden Delicious, shading after 19 and 26 days reduced fruits per 100 flower cluster to the same extent as with chemical + hand thinning. There was no difference between the two net types. For Topaz, shading after 19 days showed the best results. Regarding inner quality of both cultivars, only sugar content for Golden Delicious could be significantly improved after 19 and 26 days shading. Further analyses are still under way (e.g. for acidity).

This study is part of an effort for increasing European consumption with fruit from sustainable production systems, the ISAFRUIT-EU-project.

Keywords: Thinning, Shading net, Flower initiation, Crop load, Fruit quality

Introduction

Apple trees have to be thinned each year in order to ensure constant crop yield and high fruit quality for the market. But, the optimal effect of chemical thinners is very dependent on weather conditions before, during and after application. Therefore, the effect of a thinning agent application might lack the necessary crop load reduction and can lead to an unsatisfactory result (Stadler & Widmer, 2003). Currently, in organic apple production, there is no agent available for fruit thinning. Crops have to be thinned out by hand or mechanically with a thinning machine (Baab & Lafer, 2005). However, in particular orchards and farm situations, this does often not lead to satisfactory results. Overall, hand thinning is the most accurate way to adjust crop load but it is also very time-consuming.

Byers *et al.* (1985) found out that shading before June drop enhances apple fruit abscission. In shading trials carried out by Berüter and Droz (1991), McArtney *et al.* (2004) and Stadler *et al.* (2005), time and impact of shading on fruit abscission was further investigated.

To determine, if shading can be used as a thinning strategy in farmers' orchards, additional trials with shading of apple trees were conducted as part of the European project ISAFRUIT (Increasing fruit consumption through a trans-disciplinary approach delivering high quality produce from environmentally friendly, sustainable production methods).

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Material and Methods

Trials in 2006: The aim of the trials in 2006 was to study the effect of shading length on crop load and fruit quality of *Elstar* and *Golden D*.

Treatments on 9-year-old apple trees: 1) Control; 2) Crop load adjusted by chemicals (NAAm both cultivars / Ethephon Elstar only) and hand thinning (positive control); 3) Shading (74% of full sun) 25 DAFB during three days and 4) Shading (74% of full sun) 25 DAFB until the peak in fruit fall was registered. Shading nets were fixed by hand on a wire just above the tree top. Temperature, humidity, crop load and crop quality were investigated. Counting of fruitlets was accomplished after fruit drop on 3rd July 2006. *Elstar* was harvested on 12th September 2006, *Golden D.* on 2nd October 2006.

Trials in 2007: The aim of the trials in 2007 was to study the effect of different shading durations (19, 26 and 33 DAFB) and different shading treatments (2m and 3m net width) on crop load and fruit quality of *Topaz* and *Golden D.*. Trees were 2.50m high.

Shading was produced by a net which reduces sunlight by 74%. The trees were in its 10-th leaf. Treatments: 1) Control; 2) Chemical treatment (NAAm 100ppm) + Hand thinning; 3) Chemical treatment (NAAm 100ppm); 4) Shading 19 DAFB (*Golden D*.: Fruit diameter 12-13mm) for 3 days, 2m-net width; 5) Shading 19 DAFB for 3 days, 3m-net width; 6) Shading 26 DAFB (*Golden D*.: Fruit diameter 16-18mm) for 3 days, 2m-net width; 7) Shading 26 DAFB for 3 days, 3m-net width; 8) Shading 33 DAFB (*Golden D*.: Fruit diameter 22-24mm) for 3 days, 2m-net width; 9) Shading 33 DAFB for 3 days, 3m-net width. Records were taken of the photosynthesis rate below net, of crop load and of crop quality. Counts of flower clusters were accomplished on 20th April and 4th May 2007. *Golden D.* was harvested on 20th September 2007, *Topaz* on 20th and 21st September 2007.

Results

Trials in 2006: Optimal crop load was achieved after 3 days shading for *Golden D.* (Fig. 1). For *Elstar*, 7 days shading resulted in optimal thinning.

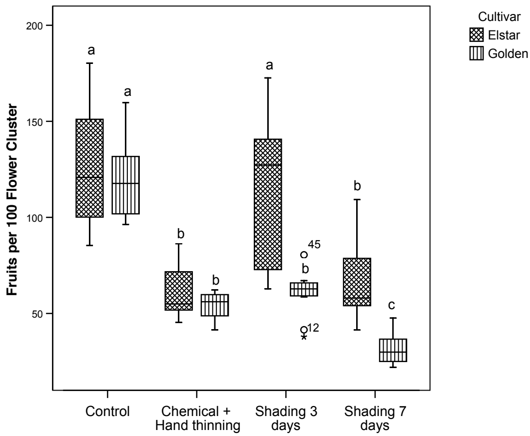
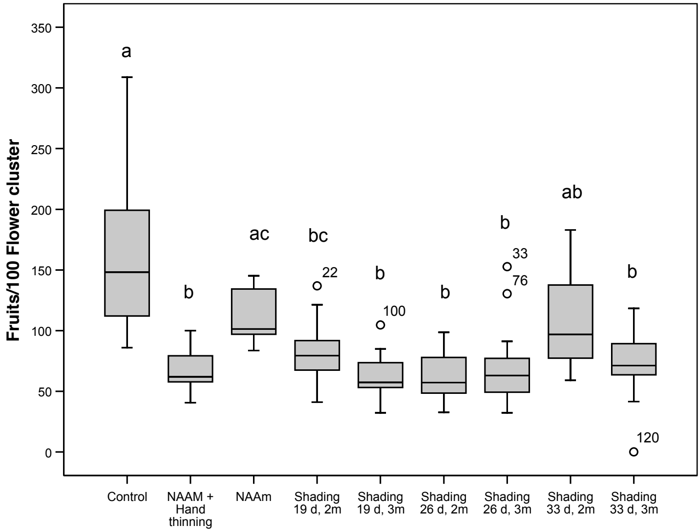


Figure 1: Number of fruits per 100 flower clusters of *Golden D.* and *Elstar* for different treatments. Gabriel test, α = 0,05; different letters for the same cultivar show significant differences.

Trials 2007



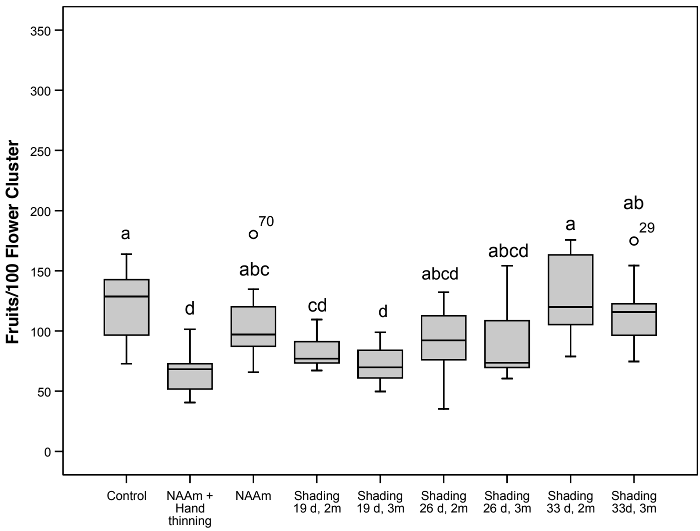


Figure 2: Number of fruits per 100 flower clusters of *Golden D.* (left) and *Topaz* (right) for different treatments. Tamhane test, α = 0,05; different letters show significant differences.

Table 1: Soluble solids, firmness, crop yield, fruit weight of *Golden D.*, *Elstar* for different treatments.

Cultivar	Treatment	Soluble solids (°Brix)	Firmness (kg/m^2)	Crop yield (kg)	Fruit Weight (g)
Golden D.	Control	11.97	8.50	17.3	80.11
Golden D.	Chem.+Hand	13.83	7.94	12.4	145.76
Golden D.	Shading 3 d	13.65	8.05	15.4	121.94
Golden D.	Shading 7 d	14.60	7.68	12.0	193.63
Elstar	Control	12.27	7.79	15.6	71.92
Elstar	Chem.+Hand	13.54	8.21	9.2	118.73
Elstar	Shading 3 d	12.77	7.77	13.2	96.17
Elstar	Shading 7 d	13.26	7.89	11.2	119.15

Regarding inner quality, 3 days shading showed good results in soluble solid content and firmness for *Golden D.* (Table 1). For *Elstar*, 7 days shading lead to good results in soluble solid content and fruit weight as compared to treatment 2.

For *Golden D.*, a three day shading at 19, 26 DAFB (2 and 3m-net) and 33 DAFB (3m-net) showed significant differences compared to the control (Fig. 2). For *Topaz*, only a three day shading at 19 DAFB resulted in a significant difference.

Table 2: Soluble solids, firmness, crop yield and fruit weight of *Golden D.* for different treatments.

Treatment	S.solids(°Brix)	Firmness (kg/m^2)	Crop yield (kg)	Fruit weight (g)
Control	11.89	7.49	29.41	137.22
NAAm+Hand thinning	12.77	7.33	23.33	181.56
NAAm	12.53	7.73	23.74	145.36
Shading 19 d, 2m	12.71	7.29	27.28	176.85
Shading 19 d, 3m	13.00	7.66	24.51	195.66
Shading 26 d, 2m	12.75	7.53	24.40	179.25
Shading 26 d, 3m	12.99	7.74	24.95	189.19
Shading 33 d, 2m	12.32	7.39	25.89	156.88
Shading 33 d, 3m	12.50	7.50	24.74	157.01

Regarding inner quality for *Golden D.*, all shading treatments lead to good results in soluble solid content (Tab. 2). For *Topaz*, a significant difference in soluble solid content is shown only after 19 days shading compared to the control (Tab. 3). For both cultivars, there is no significant difference in firmness.

Table 3: Soluble solids, firmness, crop yield and fruit weight of Topaz for different treatments.

Treatment	S.solids(°Brix)	Firmness (kg/m^2)	Crop yield (kg)	Fruit weight (g)
Control	11.63	7.52	24.94	123.57
NAAm+Hand thinning	13.09	7.97	16.74	161.22
NAAm	12.23	7.77	21.84	124.31
Shading 19 d, 2m	12.40	7.70	23.19	160.48
Shading 19 d, 3m	12.57	7.88	19.22	173.66
Shading 26 d, 2m	12.26	7.64	25.03	149.68
Shading 26 d, 3m	12.25	7.63	21.82	153.90
Shading 33 d, 2m	11.96	7.62	23.74	128.27
Shading 33 d, 3m	11.83	7.48	27.65	124.90

Discussion

Our shading trials conducted in 2006 and 2007 showed good potential for an alternative to chemical thinning. The crop load can be regulated to the necessary extent, the achieved fruit quality is acceptable and flower counts in 2006 and 2007 on the shaded apple trees showed that alternate bearing can be decreased by this method. Cultivars respond differently to the length of shading. However, trials in 2007 have shown that there is a time period during which the tree response to shading is acceptable, allowing therefore some flexibility in applying the shading. Results obtained during the recent years demonstrate that the response of the method to different years (meteorological conditions) seems to be surprisingly low (data not shown) which would allow for the development of robust, standardized methods. Practicability of the method in farmers' orchards has to be improved, however. By using the same nets several times for cultivar specific shading in different orchards, material costs could probably be reduced. In some trials, no significant differences were observed between a net with a 2m and 3m-width. By using the 2m-width net, costs may also be reduced. Net installation is still too costly and time-consuming, therefore easy to handle and cheap methods must be developed.

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