Crop regulation with single row netting structures and their influence on crop quality

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Abstract

In organic apple growing in South Tyrol, yield control is commonly achieved by removing buds and flowers with mechanical thinning machines and/or lime sulphur sprays. Netting structures have been tested in several trials for codling moth control, and promising results were obtained not only for codling moth control, but also for crop regulation (thinning). The trials conducted in 2010 and 2011, aimed at investigating the influence of different timings of net deployment (before bloom and during bloom, respectively) on thinning. Furthermore, also any possible negative side effect of the net was recorded. In both study years, a clear thinning effect of the netting structure emerged both before and after June fruit drop, resulting in increased fruit weight at harvest. Net deployment before bloom resulted in a significantly higher thinning effect than that during bloom, but in the plots netted before bloom also an increased number and severity of deformed fruits was recorded.

Keywords: apple, thinning, single row netting structures

Introduction

Yield control is an essential practice in apple growing to obtain consistent and high-quality production. In integrated farming systems, growers rely primarily on synthetic plant growth regulators. These products are not allowed in organic farming. Thinning is done at flowering using mechanical thinning machines (Strimmer *et al*., 1997; Kelderer *et al*., 2009; Weibel & Walther, 2003) and/or applying lime sulphur sprays (Kelderer *et al*., 2006).

The codling moth (*Cydia pomonella*) is one of the major pests on apple. Previous trials with netting structures (Romet *et al*., 2010; Kelderer *et al*., 2010) showed that netting trees can be a valuable tool for controlling this pest. As a side effect, fruit thinning has been recorded. We therefore decided to investigate the effect of netting structures, primarily designed for the control of codling moth, on fruit set reduction by deploying (closing) the nets already at flowering. In particular, two different timings of net deployment, respectively before bloom and during bloom, were investigated. The thinning effect before and after June fruit drop, yield, fruit weight, and fruit deformation index were recorded.

Material and Methods

Trial design

The trials were conducted in 2010 and 2011 in two apple orchards at the Research Centre Laimburg (Pfatten, South Tyrol, Italy). In 2010, the apple variety was Gold Rush, in 2011 Golden Delicious Reinders. Both study orchards are located in the valley floor at 220 m above sea level. The black hail net used in the trials had a mesh size of 2.0 × 6.0 mm, and was deployed on single rows on plots of 12 meters in length. A randomised block design with 3 replicates per treatment was used. Assessments were conducted on 5 trees per plot, uniform in growth, size, and number of flowers. A detailed description of the study orchards, the tested treatments and the timing of net deployment is provided in Table 1 and 2.

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Table 1: Description of the study orchards (variety, rootstock, planting year, planting density) in 2010 and 2011

Year	Variety	Rootstock	Planting Year	Planting density
2010	Gold Rush	M9	1996	1,2 x 3,4 m
2011	Golden Delicious	M9	1993	0,7 × 3,5 m

Table 2: Tested treatments, date of net deployment and crop stage at net deployment in 2010 and 2011

Year	Treatment	Date of net deployment	Crop stage at net deployment
2010	Black hail net before bloom	07/04/2010	Most flowers with petals forming a hollow ball (BBCH 59)
	Black hail net during bloom	16/04/2010	First flowers open (BBCH 60)
	Untreated control	-	-
2011	Black hail net before bloom	05/04/2011	Most flowers with petals forming a hollow ball (BBCH 59)
	Black hail net during bloom	08/04/2011	Full flowering (BBCH 65)
	Untreated control	-	-

Assessments

Thinning: to assess for the thinning efficacy of the different treatments, in each plot, before and after June fruit drop, the number of fruits was counted on 100 randomly selected flower clusters (henceforth FC) per tree. To take into consideration also the position of the flowers on the tree, 40 FC were selected in the upper third of the tree, and 60 in the lower part of the tree, uniformly distributed within the outer and inner part of the tree canopy. Counts were made using Fankhauser's method (Fankhauser *et al*. 1979): after June fruit drop, the number of fruits was counted on all FC present on entire branch sections. The number of fruits per 100 FC was then inferred by calculating the mean value of the assessed data.

Yield (kg/tree), fruit weight (g), and fruit deformation index: at harvest, all fruits present on the 5 sample trees within each plot were harvested, and fruit yield and fruit weight (in 2011), and the fruit deformation index (in 2010) were assessed. Fruit yield and fruit weight were determined using a sorting machine from AWETA. Fruit deformation was estimated visually by using a scale ranging from 0 = no deformation to 3 = severe deformation. Based on this classification the index (weighted average) has been calculated.

The number of fruits/100 FC, yield, fruit weight, and fruit deformation index were compared across treatments using 1-way ANOVAs followed by Student-Newman-Keuls' test for posthoc comparisons of means ($P<0.05$). To improve homoschedasticity, data expressed in percentages were arcsin(radq(x/100))-transformed. All analyses were performed with the statistics programme PASW 17.

Results

Table 3: Trial results 2010. Assessments before and after June fruit drop for no. fruits/100 FC, at harvest for fruit deformation index.

Treatment	No. Fruits/100 FC*		No. Fruits/100 FC**		Fruit deformation index
Black hail net before bloom	142.1	a	63.4	a	0.2
Black hail net during bloom	183.7	b	88.9	b	0.1
Untreated control	248.0	c	118.6	c	0.1

*Number of fruits per 100 flower clusters before June fruit drop

**Number of fruits per 100 flower clusters after June fruit drop

In the first trial year (2010), the black hail net was placed over the trees on a single row to reduce photosynthesis and thus to cause a thinning effect (Table 3). Two different timings of net deployment were tested, respectively before bloom and during bloom, and compared to an untreated control. Already before June fruit drop, a statistically significant thinning effect of the hail net emerged. Closing the net before bloom caused the strongest thinning effect (142 fruits/100 FC), followed by deploying the net during bloom (184 fruits/100 FC). In both treatments the number of fruits/100 FC was significantly lower than in the untreated control (248 fruits/100 FC). The same trend was observed also after June fruit drop. The strongest thinning effect emerged by deploying the net before bloom (63 fruits/100 FC), followed by closing the net during bloom (89 fruits/100 FC). The number of fruits/100 FC was again highest in untreated control (119 fruits/100 FC), with all treatments differing significantly one from the other. Regarding the occurrence of deformed fruits, deploying the hail net before bloom caused an increase in the number and severity of deformed fruits. The mean fruit deformation index in the plots where the net was deployed before bloom, amounted to 0.24, and was considerably higher than that recorded in the plots where the net was deployed during bloom, and that of untreated control plots (0.11 for both treatments).

Table 4: Trial results 2011. Assessments before and after June fruit drop for no. fruits/100 FC, and at harvest for yield and fruit weight

Treatment	No. Fruits/100 FC*		No. Fruits/100 FC**		Yield (kg/tree)		Fruit weight (g)	
Black hail net before bloom	141.7	a	84.7	a	43.9	a	181.3	b
Black hail net during bloom	153.5	a	103.0	b	46.5	a	178.9	b
Untreated control	205.9	b	131.1	c	52.3	a	146.7	a

*Number of fruits per 100 flower clusters before June fruit drop

**Number of fruits per 100 flower clusters after June fruit drop

In the second trial year (2011) the same treatments, respectively deploying the hail net before bloom and during bloom, were tested. Before June fruit drop, the two hail net treatments showed a significant thinning effect in comparison to the untreated control (mean n. fruits/100 FC: 142 and 153 versus 206), but differences between treated plots were not significant (Table 4). After June fruit drop, instead, the number of fruits/100 FC was lowest in plots where the hail net was deployed before bloom (85 fruits/100 FC), intermediate in those where the net was closed during bloom (103 fruits/100 FC), and highest in untreated control plots (131 fruits/100 FC), with each treatment differing significantly one from the other. No significant differences among treatments in yield

emerged, but mean fruit weight was significantly higher in the two hail net treatments (181 and 179 g) than in the untreated control (147 g).

Discussion

In organic farming in South Tyrol, yield control is achieved using mechanical thinning machines and/or lime sulphur sprays. With the aim of reducing fruit set, the deployment and thus closure of hail nets, primarily designed for the control of codling moth, at two different timings, respectively before bloom and during bloom, was tested at the research centre Laimburg (South Tyrol, Italy) in 2010 and 2011. The trials were conducted in integrated apple orchards (training system: spindle). As it is known that trees have a different behaviour under integrated and organic conditions, it would be interesting, to conduct this experiment also under organic conditions. However it has to be clear, that thinning effects vary significantly between different cultivars, orchards and areas and so there will never be one single thinning indication for all apple growing.

In both study years, a significant thinning effect of the net was recorded, both before and after June fruit drop. Closing the net before bloom resulted in a significantly higher thinning effect than deploying it during bloom.

In 2010, also the influence of the hail net on the occurrence of deformed fruits at harvest was investigated. Deploying the net before bloom resulted in an increased number and severity of deformed fruits in comparison to the untreated control, while closing the net during bloom did not.

In 2011, yield and fruit weight in the different treatments were assessed at harvest. The hail net did not significantly affect yield (kg/tree), while, irrespective of the timing of net deployment, mean fruit weight was significantly higher in plots covered with the hail net than in untreated control plots.

It can be concluded that covering trees with hail net before bloom and during bloom has a promising thinning potential on apple, resulting also in increased mean fruit weight. Closing the net before bloom provides for the highest thinning effect, but at the moment the risk of deformed fruits can not be excluded.

As a next step, it could be interesting to test the use of hail nets for thinning on different apple varieties.

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