Tree shading: an efficient method to control alternate bearing?

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Abstract

Conventional and integrated fruit growers, but not organic producers, have the possibility to use thinning agents (e.g. benzyl adenine), which allow crop regulation at a relatively late stage (10-16 mm fruit size). A few surveys have shown that by reducing net photosynthesis after blossom, June fruit drop increases. This could be an interesting new approach for organic apple orchards. Since 2003, different trials have been carried out at the Laimburg Research Station on the variety Golden Delicious rootstock M9 to devise a method for practical use by fruit growers. Unfortunately, there are still several constraints to the practical application of the shading method, not least because it does not sufficiently reduce alternate fruit bearing in the following year.

Keywords: apple, June drop, organic orchards, photosynthesis, thinning.

Introduction

With the exception of hand thinning, there are no available thinning measures in organic fruit growing after blossoming (Kelderer *et al.*, 2003). Further, in the near future even conventional and integrated fruit producers in South Tyrol will lose a thinning agent (Carbaryl) which currently enables them to regulate production at a relatively late point in time (at 10-16 mm fruit size, depending on variety; Waldner 2003). As it is still difficult to evaluate the progress of pollination at earlier time-points, these "late" thinning agents are very popular with producers. Several studies (Corelli, 1994; Bertschinger, 1997; Lafer, 2007) have proven a positive response of June drop to targeted short-term shading of the fruit trees in the post-bloom period. This knowledge could offer a new possibility of thinning for organic apple production and offer a substitute for Carbaryl to conventional producers.

Between 2003 and 2006, various field experiments were carried out with the goal of increasing June drop through varying methods. Principally shade nets and various bentonites were used, which in pre-tests were shown to be effective in reducing net photosynthesis for a few days.

Material and Methods

Test area. – Randomized blocks with quadruple repetition of the treatments were used in all experiments. Each block contained 5 trees (Golden Delicious/M9). The evaluation was made using comparable trees with strong and uniform bloom intensity.

Test preparations and treatments. – The nets used were customary black shade nets. These were laid over the trees and secured to the trunk with wire. In the sprays, various bentonites were used. In order to strengthen the shading effect, active charcoal was added to some sprayings. An overview of treatments and conditions is given in Table 1.

Evaluation. –To record the thinning effect, the number of fruits per bunch of 100 blossoms was counted. Russet evaluation was recorded by determining the percentage of heavily russeted fruit, *i.e.* fruits with surface russeting exceeding 30%. The flower bud evaluation was made by a visual estimation of the percentage of flower buds.

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Table 1: Details of fruit-thinning treatments employed in the experiments.

Yr	Treatment	Type/Name	% of lght reduction	Maufacturer	Date of treatment	D. after bloom	Fruit size	D. of shading	Dosage/hl	hl/ha	# Treat-ments
2003	Shade net	Bartex	90	Artes-Politecnica	09 - 20.05.2003	27	15,7mm	11			
	Bentonite 1	Surround		Engelhard	09.05.2003	27	15,7mm		10 kg	20	5
	Bentonite 2	Surround + Argilla rossa		Engelhard + Molinà	09.05.2003	27	15,7mm		5 + 5 kg	20	5
	Control										
2004	Shade net	Bartex	40	Artes-Politecnica	10 - 19.05.2004	21	12 mm	10			
	Shade net	Bartex	90	Artes-Politecnica	10 - 13.05.2004	21	12 mm	3			
	Shade net	Bartex	90	Artes-Politecnica	19 - 22.05.2004	30	15 mm	3			
	Shade net	Bartex	60	Artes-Politecnica	19 - 22.05.2004	30	15 mm	3			
	Shade net	Bartex	90	Artes-Politecnica	26 - 29.05.2004	37	23 mm	3			
	Control										
2005	Shade net	Bartex	60	Artes-Politecnica	06.- 09.05.2005	15	6 mm	3			
	Shade net	Bartex	90	Artes-Politecnica	06.- 09.05.2005	15	6 mm	3			
	Shade net	Bartex	60	Artes-Politecnica	16-19.05.2005	22	12 mm	3			
	Shade net	Bartex	90	Artes-Politecnica	16-19.05.2005	22	12 mm	3			
	Bentonite + act. charcoal	Edasil + Argilla rossa + Surround + Carbopal		Süd-Chemie + Molinà + Engelhard + IBA S.p.a.	20.05.2005	29	15 mm		Bentonite 4,5kg + 4,5kg + 1kg act. charcoal 3 kg	15	5
	Shade net	Bartex	60	Artes-Politecnica	20-23.05.2005	29	15 mm	3			
	Shade net	Bartex	90	Artes-Politecnica	20-23.05.2005	29	15 mm	3			
	Shade net	Bartex	60	Artes-Politecnica	27.-30.05.2005	36	23 mm	3			
	Shade net	Bartex	90	Artes-Politecnica	27.-30.05.2005	36	23 mm	3			
	Control										
2006	Shade net	Bartex	75	Artes-Politecnica	15-18.05.2006	22	15 mm	3			
	Shade net	Bartex	90	Artes-Politecnica	15.-17.05.2006	22	15 mm	2			
	Shade net	Bartex	90	Artes-Politecnica	22-24.05.2006	29	22 mm	2			
	Bentonite + act. charcoal	Bentonite montmorillonitica + Carbopal		IBA S.p.a. + Donau Carbon	19.05.2006	26	20 mm		10kg Benonite+ 3kg act. charc.	15	5
	Control										

Table 2: Thinning effects, russeting, and flower bud formation in the following year:

Year	Treatment	% light reduct.	Fruit size	Days of shading	Thin. effect %	Stat.*	% heavy russeting	% flower buds	Stat.*
2003	Shade net	90	15,7 mm	11	97,1	a	36,9	92,5	d
	Bentonite 1		15,7 mm		15,2	b	18,2	13,0	b
	Bentonite 2		15,7 mm		28,8	c	25,3	18,5	c
	Control						65,2	1,6	a
2004	Shade net	40	12 mm	10	7,64	a	24,1	4,0	a
	Shade net	90	12 mm	3	21,7	ab	21,1	16,0	b
	Shade net	90	15 mm	3	64,6	c	29,2	52,7	c
	Shade net	60	15 mm	3	36,0	b	24,7	13,5	b
	Shade net	90	23 mm	3	34,6	b	20,8	8,0	a
	Control						18,6	2,0	a
2005	Shade net	60	6 mm	3	-8,50	a		11,5	ab
	Shade net	90	6 mm	3	8,70	ab		11,1	ab
	Shade net	60	12 mm	3	19,7	bc		27,4	c
	Shade net	90	12 mm	3	66,8	d		64,0	e
	Bentonite		15 mm		30,8	c		3,5	a
	Shade net	60	15 mm	3	12,9	bc		25,8	c
	Shade net	90	15 mm	3	84,3	e		76,5	f
	Shade net	60	23 mm	3	4,80	ab		19,5	bc
	Shade net	90	23 mm	3	62,6	d		48,0	d
	Control							10,0	ab
2006	Shade net	75	15 mm	3	39,1	bc	10,1	14,8	b
	Shade net	90	15 mm	2	57,0	d	9,18	29,3	c
	Shade net	90	22 mm	2	43,6	c	4,73	13,8	b
	Bentonite		20 mm		26,9	ab	1,10	1,67	a
	Control						3,30	3,8	a

Statistics: One-way ANOVA, Tukey's Post-Hoc repeated comparison p=0,05

Results

A summary of all results discussed below is given in Table 2.

In 2003, the first data regarding the shading method were collected, using nets with a 90% reduction of light transmission. These nets were left in the orchard until the first fruit began to fall. This period of shading was clearly too long and resulted in nearly 100% thinning. The darker of the two bentonite combinations showed better thinning effects. All shading treatments seemed to lead to reduced russeting. As expected, the degree of blossoming in the following year was very high with the net method (almost 100%). At 13% and 18% flower buds, the other treatment variations provided at best modest results, which were nonetheless an improvement over the unshaded control (1.6%).

In 2004, various shading intensities and treatment periods were tested, whereby a light reduction of less than 60% resulted in almost no thinning effect, in spite of an extended period of shading (10 days). The best thinning effect was obtained when the shading was carried out at a fruit size of 15 mm (up to 64% thinning effect). Using 90% light reduction, the thinning effect was twice as high (64%) as when using 60% light reduction (36%). There were no noticeable differences in russeting between the variations. At the next blossoming, only the 90% light reduction treatment showed an entirely satisfying flower bud share of 52%.

In 2005, different shading dates and shading intensities were again tested. The best thinning effect was obtained between 12 and 23 mm, whereby the highest effectiveness was shown at 15 mm fruit diameter.

The variation with 60% light reduction showed a maximum thinning effect of 19.7% which was unsatisfactorily low. When active charcoal was added to the bentonite variation to improve shading, a satsfactory thinning effect of 30.8% was obained. The following year's blossoming was very good using all variations of 90% light reduction except for the first date. In contrast, variations with 60% light reduction were barely satisfactory, giving flower bud shares between 19.5 and 25.8%. The bentonite variation resulted in a very low flower bud share of 3.6%, in spite of satisfactory thinning effects.

In 2006, all net variations showed strong thinning effects (39-57%). The bentonite variation also gave satisfactory results with 26.9% thinning. The net variation caused a slight increase in russetting. In the following year, only the net variation with the heaviest thinning effects (57%) also brought satisfactory results with respect to alternate bearing (29.3% flower buds). The bentonite variation again performed poorly with a flower bud share of 3.8%.

Discussion

In the experiments described here, net shading consistently yielded promising thinning effects. Duration of shading, shading intensity and the period of treatment had a decisive influence over the resulting thinning effect. The best thinning effect was achieved at 15 mm fruit size. Noteworthy thinning effects could not be achieved below 60% light reduction. The effect on blossoming in the following year was mostly unsatisfactory when using the net variations. Applications of bentonite gave partially sufficient thinning results, yet had no positive effect on the alternate bearing in the following year. Also, soiling of the fruit was still visible at the date of harvest. At the moment, shading with nets is therefore the only possibility to selectively promote June drop and thereby achieve thinning. It is, however, questionable if this method will find its way into practice. High costs of acquisition and expenditure of time in application as well as the poor influence on alternate bearing are surely solid arguments for questioning the advantages of this method.

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