The Golden Sunshine Line® - a new apple series from breeding to marketing

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Abstract

'Opal', 'Sirius', 'Orion' and 'Luna' are four yellow coloured new apple varieties from the breeding Institute of Experimental Botany AS CR in Prag / Czech Republic. In organic apple production a yellow coloured apple variety, which might be an alternative to 'Golden Delicious', still is not found. All four varieties are resistant to apple scab (Venturia inaequalis). Two of them have better fruit quality and nearly the same storage life like 'Golden Delicious' which was one of the parents. The varieties were tested in different levels of growing intensity. In the first level no fungicides at all were sprayed and no fruit thinning was done. In the second level of testing the number of trees was larger and they were grown under the conditions of organic farming including fruit thinning. The results show that 'Opal' and 'Sirius' are interesting new varieties with yellow fruit colour. Also is presented an international marketing project to introduce these varieties in organic farming.

Keywords: apple varieties, resistance to apple scab, fruit thinning, marketing

Introduction

In organic apple production a yellow coloured apple variety, which might be an alternative to 'Golden Delicious', still is not found. 'Golden Delicious' itself is very susceptible to apple scab (*Venturia inaequalis*), therefore it is difficult to produce this variety under the conditions of organic farming especially in the Northern part of Europe because of the wet weather conditions. In recent times the Institute of Experimental Botany AS CR in the Czech Republic introduced four new yellow coloured apple varieties. Three of them ('Opal', 'Luna' and 'Sirius') result from a cross-breeding between 'Topaz' and 'Golden Delicous' or vice versa. 'Orion' descends from a cross-breeding of 'Golden Delicious' and 'Otava'. All four varieties are resistant to apple scab (*V. inaequalis*) based on the *Vf* gene of *Malus floribunda 821*. Two of them are triploid varieties ('Sirius' and 'Orion').

Material and Methods

All experiments took place at the State Institute for Viticulture, Oenology and Fruit Technology Weinsberg (LVWO) which is located in the Neckar valley next to the city Heilbronn. The average temperature per year is 9.5 °C with an average rainfall per year of 620 mm. Because of the warm climate conditions and good soils the agricultural areas of the region are predominantly used for viticulture.

Variety testing was practiced in two levels. In level 1 the varieties were grown with a number of 10 trees in comparison to 'Topaz', which is a standard variety in organic fruit growing in the northern part of Europe. The varieties were cultivated on rootstock M9, fungicides were sprayed only until the end of the flowering period to prevent the break-through of scab resistance by combat of the ascospores. The trees were educated as

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slender spindle trees. No fruit thinning was done to see the effects of alternate bearing. Main topics of the level-1-tests were to gain data about the phenotypical attributes, susceptibility to diseases, growth, alternate bearing, amount of yields and fruit qualities (table 1). Data were collected 4-6 years.

In level 2 32 trees of the cultivars 'Orion, 'Sirius' and 'Luna' and 96 trees of 'Opal' were planted in December 2005. This plot was cultivated under organic conditions, including few applications like NeemAzal® T/S, *Bacillus thurigienis*, mating disruption in combination with granulose-virus. Only some treatments with copper (< 1.5 kg Cu/year*ha) and wetting sulphur were done to prevent infections by scab (breaking of scab-resistance happened in the past sometimes on a low level) or mildew. Thinning by hand is an important part of cultivation to equalize crop loading and improve fruit quality.

Because of some striking differences in yield and losses the results of a mixed row of some remaining trees of Luna', 'Sirius' (each 8 trees) and 'Opal' (14 trees), where the same applications were done like at 'Elstar' or 'Pinova', shall be part of the discussion (marked as "row 4' in the tables and figures). Data about phenlogy, yield, size, colouring and quality were assessed. Special details as reaction on organic cultivation in combination with weather conditions in the years 2007-2009 were described.

Additional to the variety testing in level 1 and 2 a research project to optimize crop loading especially on 'Opal' was started in spring 2009. Because it was known from the results of the mentioned variety testing, that heavy yields and small fruits are the major problems of this variety. Thinning by hand or lime sulphur was compared to a not thinned control (2 x 6 trees per treatment). Lime sulphur was applied with a hand-gun sprayer (3 x 25 l lime sulphur/ha + 1.5 l Bioblatt Mehltaumittel/ha). On June 10th all trees were thinned by hand (except for control). The following parameters were evaluated: blossom clusters/tree (in stage red bud), time for thinning by hand, yield, numbers of fruits/tree, mean fruit weight, size and colouring of fruit (green, green + red flash, yellow, yellow + red flash). Firmness, content of sugar (° Brix) and decrease of starch were measured of a mixed sample of each treatment. Because striking differences were seen at the infections by sooty blotch, the results will be presented here, too.

Some scab-resistant cultivars are more susceptible to sooty blotch, when less fungicides are applied, losses by sooty blotch can endanger the profitability of an organic produced cultivar, especially in region of Lake Constance (Buchleither & Späth 2007). In 2009 after harvest a mixed sample of about 350 fruits per treatment was evaluated for sooty blotch and russeting using the following patterns:

Russeting	Sooty Blotch
R1: no symptoms	S1: traces
R2: 1 - 10% of fruit surface	S2: < 10% of fruit surface
R3: 10 - 30%	S3: 10 - 25%
R4: > 30%	S4: 25 - 50%
	S5: > 50%

Disease severity (P) of Sooty Blotch was calculated according to Mayr & Späth, 2008 (n= number in each class, v=1 for class S1 etc., N=total number):

$$P = \frac{\sum (n*v)}{(v-1)*N} *100$$

Results and Discussion

In level 1 data of vegetation of all tested varieties were nearly the same, probably due to the same parents (table 1). Except for 'Luna' harvest time is at the end of September close to the harvest of the varieties 'Topaz' and 'Golden Delicious' (Egger et al., 2009). This might be a problem of harvest organisation in farms with more varieties in this ripening time.

Table 1: Level 1 performance (no fungicides) of the varieties of the Golden Sunshine Line® in comparison to 'Topaz' (Standard), all varieties were propagated on rootstock M9, data were collected over 4-6 years, scale 1-4 or scale 1-9, 1 = no symptoms, 4 (9) = heavy symptoms

Variety	**Topaz**	**Opal**	**Sirius**	**Luna**	**Orion**
Data of vegetation					
Beginning of Vegetation	25th, March	25th, March	27th, March	23th, March	24th, March
Flowering	25th, April	24th, April	25th, April	25th, April	23th, April
Harvest time	28th, September	24th, September	26th, September	7th, October	23th, September
Days flowering until harvest	153	150	151	162	148
Susceptibilty to diseases					
Apple scab (1-4)	1	1	1	1	1
Powdery mildew (1 – 4)	1,3	1,2	1,2	1,1	1,4
Yield, growth, fruit data and storage life					
Potential of yield Absolute on M9 Rel. Crown volume	High 100% 100%	Very high 130% 70%	High 125% 118%	High 132% 91%	Middle 70% 70%
Tendency to alternate bearing	low	low	low	Very low	low
Growth Rel. Trunk diameter	Middle 100%	Middle-strong 150%	Middle 126%	Middle 113%	Middle 127%
Weight of fruits Packout 70-85 mm Russeting (1-9)	153 g 80,8% 62% > 3	147 g 57,9% 95% > 3	188 g 80,8% 43,6% > 3	150 g 68,5% 15% > 3	211 g 60% 68,9% > 3
Storage life in cold storage at 3-5 °C	Until March	Until April	Until February	Until February	Until February
Fruit quality and inner contents at harvest time					
Firmness of flesh (kg/cm^2)	7,7	8,3	7,8	8,4	7,7
Sugar content (% Brix)	13,5	14,2	14,2	13,5	14,5
Decrease of starch (1-10)	5,5	6,5	6,5	4,7	4,5
Amount of acids (g/litre)	10,1	7,1	8,8	9,4	8,4
Relation sugar to acid (acid = 1)	13,4 : 1	20 : 1	16,1 : 1	14,4 : 1	17,3 : 1

Susceptibility to diseases was low in general. There were no problems with the main fungal diseases apple scab and powdery mildew. One tree of 'Opal' was lost by *Nectria galligena*. In 2009 'Luna' showed heavy symptoms of apple proliferation. All varieties were infected by sooty blotch.

All new varieties had a high potential of yield, which was higher than the capacity of the standard variety 'Topaz'. Especially on rootstock 'M9' yield was higher than 'Topaz', but also growth was more stronger. The tendency of all tested varieties to alternate bearing was low, comparable to the level of a variety like 'Golden Delicious'. 'Opal' and 'Sirius' were the most attractive varieties, because of their shining yellow ground colour and a little red blush. 'Luna' had a pale yellow ground colour and 'Orion' too much lenticels. At harvest time 'Opal' should be picked only with this typical ground colour. Therefore 'Opal' should be harvested several times.

The taste of 'Opal' was sweet because of its high amount of sugar content and little amount of fruit acids. Without fruit thinning fruit size was only 147 g, which was lower than 'Topaz'. Among the tested varieties 'Opal' was the most susceptible to russeting. Therefore it has to be grown only in best climatic conditions (warm and dry). 'Opal' had a very good storage life. During storage firmness of the fruit flesh didn't get lost.

'Sirius' is a triploid variety. Because of that fruit size was bigger (188 g). Just like 'Opal' this variety had a high amount of sugar content, but more fruit acids. Therefore taste was more well-balanced. Unfortunately firmness of fruit flesh decreased during storage similar to 'Topaz'. Both varieties can be stored in controlled atmosphere.

In level 2 the intention was to start with well-balanced yield in the first years, so thinning was an important part of cultivation strategy. Table 2 summarizes some data about yield and fruit weight in different parts of the organic cultivated plot (see material and methods).

Table 2: total yield per tree (kg, unsorted) and average fruit weight of 'Sirius', 'Opal' and 'Luna' 2007-2009 (in 2009 without data from thinning experiment)

cultivar/year	yield/tree (kg)				average fruit weight (g)			
	2007	2008	2009	Σ 2007-2009	2007	2008	2009	Ø 2007-2009
Sirius row 2	1.61	7.01	10.75	19.37	215	242	230	229
Sirius row 4	1.25	6.86	11.81	19.92	230	286	226	247
Opal row 2/3	2.27	5.49	13.14	20.90	239	154	135	177
Opal row 4	2.23	6.04	13.30	21.57	235	188	156	193
Luna row 1	1.74	5.19	8.18	15.11	199	177	202	193
Luna row 4	2.98	8.09	12.06	23.13	229	194	196	206

The main difference between the results of rows 1/2/3 and row 4 was date and partly intensity of thinning by hand. Row 4 was thinned about 2 weeks earlier, according to the first time of 'Elstar', so the average fruit weight was higher than in the other rows, especially for 'Opal'. Figure 1 shows the influence of different crop load on size of the apples of 'Opal' in 2009, figure 2 describes the proportions of low and high fruit quality by different thinning intensities.

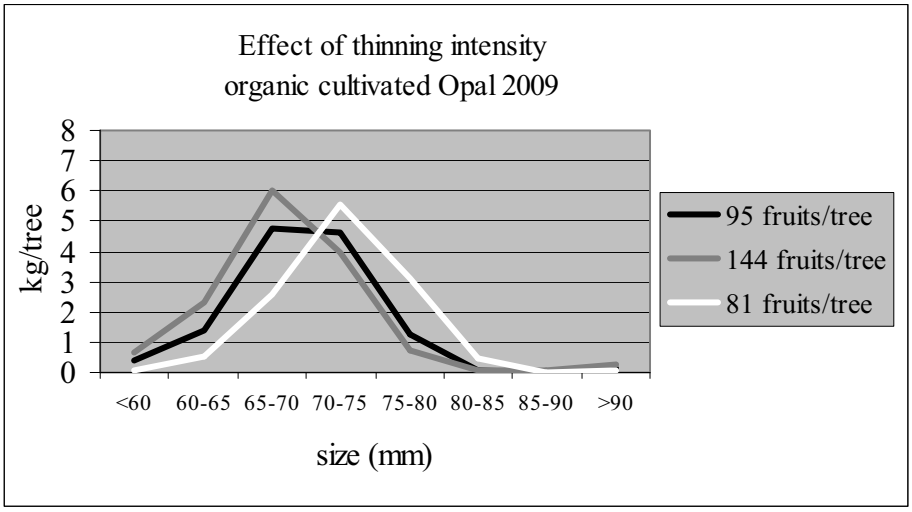

Figure 1: Effect of different thinning intensity on size of 'Opal' in 2009

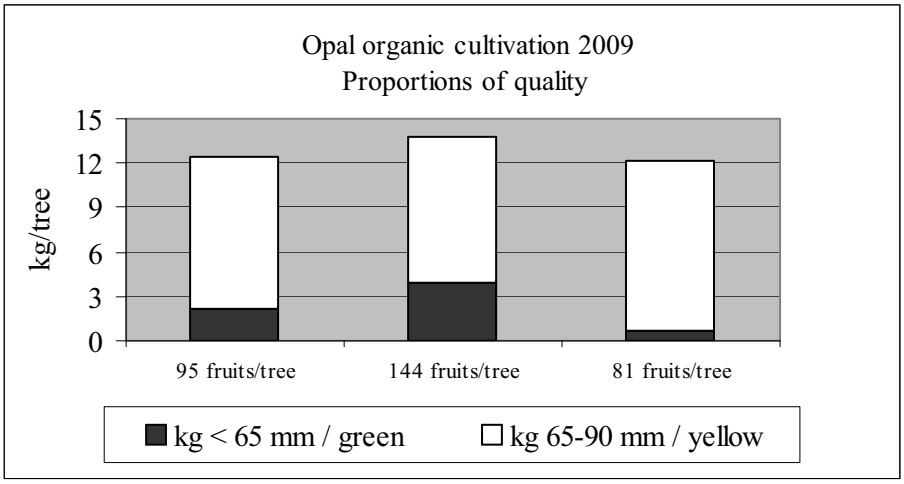

Figure 2: Effect of different thinning intensity on quality-proportions of 'Opal' in 2009.

In the years before sooty blotch had been no real problem for 'Opal', Sirius' and 'Orion' in the organic cultivated plot, 'Luna' had some more problems because of the late picking date (begin of October). But in 2009 there were lots of wet days or days with high humidity and long durations of wetness on leaves and fruits, so the infection risk by sooty blotch was even for 'Opal' high. As consequence of higher plant protection intensity in row 4 only 11.5 % were not marketable in 2009 in comparison to 33 % in row 2/3, loss mainly was caused by sooty blotch. A cultivar susceptible for scab would have nearly 90 % not marketable fruits in 2009, when it would be cultivated with the same low plant protection intensity as the plot in rows 1,2,3.

Other striking differences between the susceptibilities on level 1 and level 2 were some more *Dysaphis plantaginea* at 'Opal', often red lenticels on 'Luna', more reticular russeting on fruits of 'Sirius' and 'Orion'. 'Luna' had some problems with *Gloeosporium sp.* during storage (winter 2008/2009), while 'Sirius' and 'Opal' showed less infections.

In thinning experiment 2009 the level of flowering intensity of 'Opal' was about 230 blossom-clusters/tree. At harvest fruit setting of the control was very high (0.74 apples/blossom cluster) in comparison to thinning by hand (0.38) and lime sulphur (0.41) or in comparison to fruit setting of control in older thinning experiments at the cultivar 'Elstar' (Eis et al. 2008).

Table 3 shows the required time for different thinning strategies. The calculation per ha - time was measured in minutes/tree - was done under the following consumptions: 2400 trees/ha were planted, only 70 % of the trees must be thinned strongly. When lime sulphur had been used during blossom only 58 h/ha were needed for thinning by hand afterwards compared to thinning only by hand (100 h/ha). As expected the total yield/tree was highest for the control (19.53 kg), reduced for thinning by hand (12.80 kg/tree) and for lime sulphur (12.38 kg/tree). Both thinning strategies enhanced the average fruit weight - that means a better picking performance - and the sugar content of the apples clearly.

Table 3: Remaining time for thinning by hand for different treatments, Data about yield and sugar content, Opal 2009 (Tukey-test, α=0,05).

	untreated control	lime sulphur + thinning by hand	thinning by hand
time for thinning by hand (h/ha)	-	58	100
yield (kg/tree)	19.53 a	12.38 b	12.80 b
fruits/tree	186 a	89 b	87 b
mean fruit weight (g)	105 a	139 b	147 b
° brix	14.7	16.1	15.1

All fruits were sorted to assess the size and colouring of the fruits using a four-grade scale (green, green+red, yellow and yellow+red). At the control about 66 % of the apples were only green and 20 % green+red flash. At the treatments with additional spraying with lime sulphur (74 %) und thinning by hand (73 %) lots of fruits were sorted as yellow+red and yellow. Using lime sulphur enhanced the number of yellow fruits with red flash a little bit.

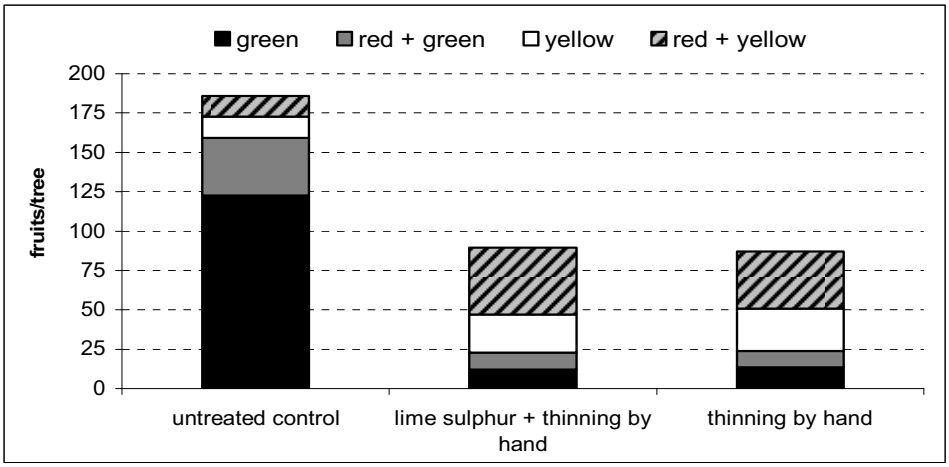

Figure 3: Number and colouring of fruits using a four-grade scale (green, green+red flash, yellow and yellow+red flash), Opal 2009.

Russeting was equal over all treatments, about half of the fruits were evaluated as R2, the rest as R3. Only 2-4 % of the evaluated fruits where put in class R4. Disease severity (see material and methods) of sooty blotch was nearly the same for control (62.5) and thinning by hand (70.0). It was reduced for the thinning strategy lime sulphur+thinning by hand (44.9), in this treatment mainly weak symptoms could be seen (see figure 4, % fruits in different classes).

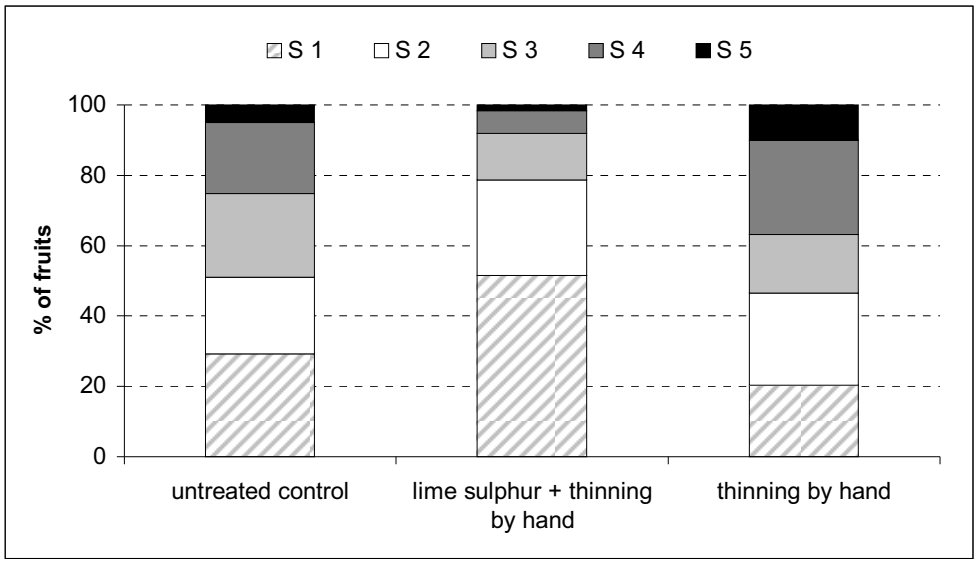

Figure 4: Percentage of apples in different classes of sooty blotch infections (S1-S5), Opal 2009.

Blossom thinning with lime sulphur balanced the crop load, so the distance between the fruits was less close at an early stage. If the reduction of sooty blotch was caused partly by the early treatments of lime sulphur during blossom themselves - lime sulphur has an effect on sooty blotch (Mayr, Späth 2008) - is not clear at the moment, this should be controlled in the next experiments again.

Marketing

The introduction of the 'Golden Sunshine Line®' is getting established on a European level and as a business to business trade mark. It is a collection of several apple cultivars which supports the idea of bio diversity (Weber, 2008). Besides that the company "Fruit Select" was founded to introduce the variety 'Opal' also in conventional farming systems. The distribution of propagation material and trees of these varieties will be organised by this company. 'Fruit Select' is a cooperation of nurseries from all over Europe.

The Golden Sunshine Line® is an example how the development of apple varieties should be done in a modern way. In a first step varieties should be tested at different locations (level 1) for at least 6 years. The most interesting varieties of level 1 should be planted with more trees and investigated on their reactions to the conditions of organic farming (level 2, 4 years). Problems of these varieties known from level 1 trials should be corrected in level 2 by cultivation techniques like pruning, plant protection or fruit thinning. After research is done, it is necessary to have a marketing concept for new varieties. Otherwise there will be no introduction into practice.

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