

# Low-residue apple production compared to common integrated and organic production

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## Introduction

In a field trial with Golden Delicious and the scab resistant varieties Topaz, Otava and Ariane, common crop protection strategies for integrated and organic apple production were compared to a low-residue strategy with reduced use of synthetic fungicides. Pest and weed control was identical to the integrated strategy. In all strategies, insecticides were used only if damage thresholds were exceeded and alternative measures were applied, being mating disruption against codling moth, mulching of leaves to reduce scab inoculum and enclosure netting to prevent pest invasion.



## Crop protection strategies

- IP** integrated pest management according to ACW recommendations
- LR** low pesticide residue production of high quality fruits
- BIO** organic pest management according to Swiss BIO-guidelines

### Disease Control

	bud break	pre bloom	bloom	Post bloom	summer	final treat.	
	scab primary season (ascospores)			scab secondary season (conidia)			
<b>IP</b>	2x dithianone	2x anilino-pyrimidines (Chorus + dithianone + S 3kg) after scab infection	2x Qol's (Flint + captan + S 3kg) after scab infection	2x DMI's (2x Score + captan) after scab infection	3x captan	1x Qol (Flint)	3 weeks
<b>LR</b>	2x dithianone	2x anilino-pyrimidines (Chorus + dithianone + S 3kg) after scab infection	1x DMI (Score + capt. + S 3kg) after scab infection	7x potassium-bicarbonate (Armcarb) 4.8kg + S 3.2kg over renewed after rainfall	Armi-carb		8 days
<b>BIO</b>	2x Copper 0.4-0.6 kg	6x Myco-San 10-12kg + S 2-3kg or Myco-Sin 6-8kg + S 6-8kg		7x potassium-bicarbonate (Armcarb) 4.8kg + S 3.2kg over renewed after rainfall	Armi-carb		8 days
	control of fire blight						enclosure netting in all strategies!

### Pest & Weed Control, Thinning

	aphids	codling moth	smaller fruit tortix	weed control	thinning
<b>IP</b>	1x triazamate (Aztec) ahead of boom		1x fenoxycarb (Insegar) end of May	herbicides	Chemical
<b>LR</b>		mating disruption			
<b>BIO</b>	1x azadichratin A (Neem Azal) ahead of boom		1x spinosad (Audienz) end of May	mechanical weeding	Mechanical (Darwin)

## Results



Scab infection of Golden Delicious

Time	Plant part	Infection incidences			
		IP	LR	Bio	Control
2008	Summer	0.0%	0.0%	22.0%	37.5%
	At harvest	1.5%	33.0%	30.0%	97.5%
2009	Summer	0.3%	0.0%	0.8%	26.5%
	At harvest	0.0%	0.8%	3.0%	65.3%
2010	Summer	0.25%	0.5%	24.5%	46.0%
	At harvest	1.25%	0.25%	11.75%	96.5%
2011	Summer	0%	0.5%	14.3%	27.8%
	At harvest	0%	0.3%	10.3%	54.5%
2012	Summer	0%	0%	20.5%	39.0%



Secondary leaf infection of powdery mildew of all varieties

Time	Variety	Infection incidences			
		IP	LR	Bio	Control
2008	Summer				
	Golden Del.	5.0%	6.5%	17.5%	33.0%
	Ariane	14.5%	15.5%	22.0%	41.5%
	Otava	9.0%	8.0%	13.5%	44.5%
	Topaz	10.0%	11.0%	17.5%	33.5%
2009	Summer				
	Golden Del.	4.5%	2.3%	15.5%	54.2%
	Ariane	5.5%	4.5%	21.0%	52.8%
	Otava	6.0%	6.0%	22.0%	37.3%
	Topaz	4.3%	5.0%	16.8%	29.3%
2010	Summer				
	Golden Del.	1.3%	6%	8.8%	39.8%
	Ariane	3.0%	4.0%	8.8%	17.5%
	Otava	2.8%	2.8%	19.8%	42.0%
	Topaz	3.5%	1.3%	10.3%	15.0%
2011	Summer				
	Golden Del.	5.8%	4.8%	13.3%	21.8%
	Ariane	16.5%	8.3%	17.8%	29.5%
	Otava	11.3%	9.3%	12.5%	32.0%
	Topaz	14.3%	6.5%	6.8%	17.8%
2012	Summer				
	Golden Del.	9.5%	1.8%	5.8%	9.5%
	Ariane	1.8%	1.5%	5.3%	13.8%
	Otava	2.5%	5.0%	6.8%	14.0%
	Topaz	1.8%	3.0%	8.8%	7.3%



Damages after 5 month of storage at 4°C

(LR: low residue; HW: post harvest hot water treatment for low-residue and Bio)

Time	Variety	Storage scab					Bull's eye rot					other					total damage								
		IP	LR	LR HW	Bio	Bio HW	C	IP	LR	LR HW	Bio	Bio HW	C	IP	LR	LR HW	Bio	Bio HW	C	IP	LR	LR HW	Bio	Bio HW	C
2009	Golden Del.	0.0	0.3	--	1.3	--	58.1	0.2	2.7	--	10.0	--	2.3	3.0	4.0	--	6.0	--	5.0	3.4	6.8	--	17.1	--	60.9
	Ariane	0.0	0.0	--	0.0	--	0.0	0.1	0.4	--	0.6	--	2.8	23.6	16.2	--	13.7	--	11.4	23.7	16.6	--	14.3	--	14.2
	Otava	0.0	0.0	--	0.0	--	0.0	0.3	6.3	--	7.1	--	24.8	4.0	2.7	--	3.1	--	7.6	4.3	9.0	--	10.2	--	32.4
	Topaz	0.0	0.0	0.0	0.0	0.0	0.0	1.6	13.3	1.5	26.5	1.5	34.3	1.4	0.7	7.5	1.8	2.2	3.3	3.0	14.0	9.0	28.3	3.7	37.6
	Golden Del.	0.3	4.0	1.2	4.3	3.2	--	1.3	9.1	0.0	9.6	0.2	--	3.7	7.3	5.3	21.0	28.1	--	5.2	20.4	6.5	35.0	31.4	--
2010	Ariane	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.9	0.0	1.9	14.2	6.4	8.9	5.0	5.3	19.6	14.2	7.0	8.9	5.8	5.3	21.5
	Otava	0.0	0.0	0.0	0.0	0.0	0.0	12.0	65.5	5.3	37.7	3.1	61.3	4.1	4.0	82.1	6.4	96.2	7.5	16.1	69.5	87.4	44.0	99.3	68.8
	Topaz	0.0	0.0	0.0	0.0	0.0	0.0	3.1	52.1	4.1	40.0	1.0	58.0	2.4	1.1	4.0	0.7	6.8	3.7	5.5	53.2	8.1	40.7	7.8	61.7
	Golden Del.	0.0	8.5	4.5	54.0	46.9	81.9	0.2	4.5	0.4	2.5	0.7	3.4	6.9	2.9	5.3	6.9	11.5	0.3	7.1	15.9	10.3	61.8	59.1	65.7
	Ariane	0.0	0.0	--	0.0	--	0.0	1.7	6.3	--	2.4	--	3.8	19.8	12.0	--	5.5	--	16.3	21.4	18.4	--	7.8	--	20.0
2011	Otava	0.0	0.0	--	0.0	--	0.0	4.7	29.1	--	32.7	--	27.1	6.1	6.1	--	8.4	--	11.3	10.7	35.2	--	41.1	--	38.4
	Topaz	0.0	0.0	0.0	0.0	0.0	0.0	12.3	60.8	6.4	73.7	5.9	59.9	3.0	2.1	2.9	3.0	6.5	9.4	15.4	62.9	9.2	76.7	14.4	69.3

## Summary

In the first year, fungicide application was interrupted in summer in the low-residue strategy. Compared to the integrated strategy, this resulted in increased incidence of fruit scab on Golden Delicious and bull's eye rot on Golden Delicious and Topaz. From the second year on, synthetic fungicides were used in Low-Residue until end of bloom. After bloom, control of diseases was done with potassium bicarbonate and sulphur. No pesticide residues could be detected with this strategy and good control was achieved for scab on Golden Delicious and powdery mildew on all varieties. Ariane was the most robust variety. Bull's eye rot at storage on Golden Delicious and Topaz remained the weakness of the low-input strategy. Hot water treatments after harvest reduced the incidence of this disease. No relevant losses due to pests were observed in any strategy during four years. The trial will be continued to collect further information on crop protection efficacy and profitability, aiming at recommendations for farmers.

