# Ecological Apple Production: a Comparison of Organic and Integrated Apple-growing

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**Abstract**

**In 1995, an experiment was planted at Wädenswil for comparing organic and integrated apple production. The overall goal of this experiment was to develop a data set which allows for an objective overall comparison of the two production concepts. Horticultural, ecological and economical traits were looked at. In practical terms, the study should particularly clarify how suitable the two systems are for producing marketable fresh fruit under Swiss conditions. The approach of an on-station comparison with a split-plot design with 3 replicate blocks and the factors "production system" (1st factor) and "variety" (2nd factor) was chosen. Ninety-four percent of Swiss apple acreage is managed according to integrated production, and 5% according to organic guidelines 2001. Conventional production is therefore lacking practical relevance and was not included in this trial. Cultivars Boskoop, Pommes Cloche, Idared and Resi were planted on rootstock M9 at a 3.4 by 1.4m spacing. The crop management was dynamically adapted every year according to the most advanced crop management technology that is appropriate in the particular in situ situation of the trial and that is permitted by the most recent Swiss guidelines for each of the two production systems. In particular, parameters of tree growth, fruit growth, yield and fruit quality, crop protection, crop economy and crop ecology were assessed. In 2001, additional analytical fruit quality parameters were measured and extensive sensory tests were performed. This study provides the first scientific comparison of organic and integrated apple production under European conditions. The paper presents preliminary conclusions while the last cropping season of the experiment is still on-going and final data analyses will be possible in 2003.**

## INTRODUCTION

Since the introduction of integrated fruit production (IP) in Switzerland in the 1980s, the IP land area  increased constantly until reaching over 80% during  the 1990s (2002: 90%; Schweizerischer Obstverband 2002). Towards the end of the 1990s, leading retail food chains begand to develop an interest in food, especially fruit, produced according to guidelines of organic (biological) production (ORG). Apple is the number 1 fruit crop in terms of production in Switzerland. Converting to organic apple production is a risky choice for growers, due to the often unfavourable climatic conditions in Switzerland and the limited production techniques that are available and compatible with organic standards. Given these constraints, it was unclear whether commercially produced organic apples could meet the retail market standards. To address this question, an on-station trial was planted in 1992 in Wädenswil to compare integrated and organic apple production. A massive hail storm destroyed the experiment in 1994. The experiment was replanted in 1995.

The objectives of the experiment were, i) to develop a science-based data set that allows for an objective comparison of the two production concepts, primarily their horticultural performance (particularly for producing first quality fruit that meet market standards) but also in terms of their contribution to sustainability, ii) to identify problem areas of both production concepts, and iii) to develop comparative and practical arguments for adopting the appropriate system in a particular orchard situation.

Since production guidelines are modified each year to the most recent technology available, experimental principles had to be defined before starting the experiment. It was agreed that while the experiment was progressing through the years, the most advanced system-compatible technology should be applied to the management of the IP- and ORG-plots. The experiment aimed at an overall, farmer-equivalent systems' comparison. However, the scientific experimental design should also allow for factorial comparisons between specific parameters in both systems.

## MATERIALS AND METHODS

The experiment was planted in 1994 in Wädenswil, Switzerland (1100 mm rainfall, sandy-loam soil, regular P/K levels). A split plot design was chosen, with the system as 1st order factor (IP and ORG), the variety as 2nd order factor, and 3 block replicates. The varieties: Boskoop (scab-robust), Glockenapfel, Idared and Resi (Vf scab-resistant) were chosen, grafted on M9 vf. The trees were planted at a 3.4 x 1.4 m spacing (inter-row x inter-tree), corresponding to a planting density of 2100 trees / ha. Each plot (35x34m; 0.199ha) included 2 adjacent rows per variety, each row totalling 25 trees of the same variety. Each plot was supplemented on each plot side with a border row (Fig. 1).
The management in the IP- and ORG-plots is specified in Table 1. Table 2 specifies the traits that have been measured.

Economic: With the results of the years 2000 and 2001, the profit of the produced fruit (price x weight) was modelled, based on the real production of non-replanted trees, scaled up to 2100 trees/ha. For the modelling, a quality break-down (class I, II) of 80% and 20% respectively was used for the IP-system, while 70% and 30% were used for the ORG-system. Swiss apple prices of 2001 were used, with CHF 0.9/kg (~0.9 CAD, 0.6 USD) and CHF 0.4/kg for class I and II IP-apples respectively, while for ORG apples, CHF 1.9/kg and CHF 1.3/kg were applied. The modelling software *Arbokost* (see www.faw.ch; Mouron and Carint, 2001) was used. This programme considers full cost, including depreciation for planting and establishing the orchard, 4% interest rate on invested capital and labour cost, accounting for the requirements of the economics of a small and medium enterprise in Switzerland and a productive orchard life span of 12 years (period of depreciation).

Mouse damage endangered the experiment seriously. The chosen ground cover management (Mypex mulch), which was chosen in both systems with the idea to avoid green cover competition in the ORG-system and to give the trees a similar start in both systems, favoured a compacted, wet-sticky soil and provided a mouse-friendly environment. As a result of this, tree growth was reduced in the first years of the experiment, some trees were even destroyed by mice. Therefore, the decision was taken in 1999, to change the ground cover management: The trees were strengthened with an additional nitrogen-dose of 6.5 kg N/ha in May/June 1999. The nitrogen was applied with Vinasse, a side line product of sugar beet production ("Biorga", 9% N). In July 1999, the Mypex mulching sheets were removed. Also, 18% of the trees had to be removed. Tree stripes were tilled twice in April 2000 with a "Ladurner"-tiller. In the IP-plots, the herbicide "Basta" (glufosinate) was applied to the tree stripes once. In spring 2000, the eliminated trees were replanted (Resi 35%; Glockenapfel: 19%; Boskoop: 9%; Idared: 7%). Weed control was assured subsequently by applying in the IP-plots 1x Basta/1x Inspire (butafenacil fluobutracil) in April/June and tilling twice in July/August, and by tilling in the ORG-plots with the "Ladurner"-tiller 4x followed by hand tilling, i.e. in April/May/July/August respectively.

## RESULTS AND DISCUSSION

While a complete report of this study will be published after finishing the field trial (2002) and further fruit quality and sensorial tests (2003), preliminary results are presented in this paper in view of the high interest in clarifying the questions addressed by this study.

Pests: Red spider mites (*Panonychus ulmi*) infestations were higher in the ORG-plots mainly at the beginning of the experiment combined with a lower presence of predatory mites (*Typhlodromus pyri*). The sulphur applications for disease control in the ORG-plots complicated the establishment of a predatory might population in these plots. However, this problem seemed to be overcome with progressing years (Fig. 2). On the other hand, the sulphur-treatments seemed to control other, usually uncommon pests like the European fruit scale, which occurred in the IP-plots in 2000 (Fig. 3). Aphids such as the rosy apple aphid (*Dysaphis plantaginea*) or the green apple aphid (*Aphis pomi*) were controlled from 1995 to May 2002 in both productions systems to the same extent, with some single evaluation dates where IP or ORG had significantly higher infestations, but with no consistent trend. From 1997 to 2001, the cumulative fruit damage (pre-harvest) in IP- and ORG-plots showed no pronounced trend, while from the 3rd leaf year onwards, fruits in ORG-plots tended to be a bit more infested. For further conclusions, results from other orchard environments would be needed (Fig. 4).

Diseases: Scab (*Venturia inaequalis*) was generally well controlled in IP- and ORG-plots. Only in organically managed Idared-plots, leaf and fruit scab incidence reached high levels (e.g. in 2001 about 30% leaf incidence and 40% fruit incidence) which may not be tolerated in commercial orchards. In Idared plots, also powdery mildew (*Podosphaera leucotricha*) incidence was high (e.g. 8% in 2001 in IP- and ORG-plots). Calyx rot (*Botrytinia fuckeliana*) was a problem in ORG-plots (Fig. 5).

Growth: Over the years, growth was slightly lower in IP-plots than in ORG-plot except in Glockenapfel-plots where trees in the IP-plots grew slightly more than in ORG-plots.

Nutritional status: In August 2001, leaf greenness was measured with a SPAD-meter. Greenness values in IP-plots were significantly higher than in ORG-plots (Tab. 3), confirming observations made in the previous years. This points to a higher chlorophyll-content and a better nutritional status of the trees in the IP-plots, which would correlate with the slightly higher growth of the trees in these plots (see above).

Flower bud formation: A trend of more flower buds (%), a better flower bud quality and greater fruitlets could be observed in IP-plots as compared to ORG-plots, even if these trends were not significant.

Fruit yield: The cumulative yields of the seasons 1997-2001 were generally slightly lower in ORG-plots than in IP-plots. This observation is consistent with on-farm data, obtained from a 4-year survey on Swiss fresh fruit apple orchards, where yields on ORG-farms proved to be up to 50% lower (Zürcher et al. 2003). The difference was most pronounced with cv. Glockenapfel, followed by Boskoop, and Resi, while with Ideared, the ORG-plot yields started higher until 2001, when IP plot yields were higher, levelling off the cumulative yield between both systems as equal. Boskoop and Resi showed a trend to alternate bearing. Idared was most productive (cumulative yield 1997-2001 ORG/IP of approx. 32 kg/tree, 67 t/ha)), followed ba Boskoop (ORG-IP: 23-29 kg/tree, 48-61 t/ha), Glockenapfel (21-28 kg/tree, 44-59 t/ha) and Resi (18-22 kg/tree, 38-46 t/ha).

Fruit quality: Fruits were graded according to the standards of the Swiss Fruit Grower’s Union (Schweiz. Obstverband, SOV; www.swissfruit.ch), which consider size, colour and further external quality parameters. Quality categories were i) first class (cl. I), ii) too big, iii) too small, and iv) lacking top colour. From 1998 onwards, fruit quality was analyzed. First class fruits represented about 40 to 83% of the production, while 0-60% were too small, 0-22% too big and 1-12% were lacking colour. If there were differences between ORG- and IP-systems, ORG-plots tended to have less premium fruit, but there were single years or block-plots, were the ORG-IP comparison was inverse. If analysing the fruit quality of all cultivars after changing the ground cover management in 1999 due to the mouse problem, external quality (according to the SOV-standards) was in 4 of total 12 cultivar-system comparisons higher in the ORG-system, while in 8 comparisons, they were higher in the IP-system (Tab. 4). No trend could be observed that could attribute the result of the comparison to a particular year.

When comparing internal fruit quality parameters, significant differences were found, mostly in favour of the ORG-system (Tab. 5). By looking at firmness (at harvest, after storage), sugar and acidity (after storage) of the fruits from 2000 and 2001, nine comparisons among a total of 28 resulted significantly in favour of the ORG-system, while 2 comparisons were in favour of the IP system. Seventeen comparisons were not significant. The most frequent differences were found for firmness. If differences were significant in firmness and/or sugar, they were in favour of the ORG-system. The IP-system had significantly higher acidity levels.

Soil analyses: The factorial comparison of soil analyses results obtained with the $H_20$-extraction method and the Ammonium actetate EDTA-extraction method gave many significant differences. In both extraction methods, ORG gave higher levels of K, Mg, Ca and organic matter. Soil nutrient levels were generally higher in ORG than in IP, except in plots with Idared (Tab. 6). The magnitude of the differences was around 10-15% (a representative example is given in Fig. 6). This may be considered as surprising, given the few years both production systems were applied to the respective plots.

For the actual data set, it may be speculated that a lower nitrogen nutrition level (reflected by lower leaf greenness) might correlate with a higher tendency to alternate bearing and slightly lower yields in the ORG-system. Further data interpretation must be awaited until the final fruit quality data for 2003 is available. The comparison of fruit quality parameters between ORG- and other production systems is controversial if looking at already published studies. Similar trends as in the Wädenswil study have been found before in another Swiss study (Weibel et al. 2000). However, another study comparing ORG-apples and conventionally produced apples does not support these results (Bordeleau et al. 2002). The final quality data of 2002/3 will show, whether they are consistent with the trends found in the presented preliminary results of the Wädenswil study. A comparison with the availability of soil nutrients will also show, how much these contribute to a possible explanation of the fruit quality and tree performance. Significant interactions between P and Ca-analyses values and the replicate blocks (Tab. 6), however, point to soil variability, which may confound the interpretation of some of the final results.

Economics: Based on this modelling, the profit of ORG-plots was 172% of the profit of IP-plots for the variety Resi, while for Idared, Boskoop and Glockenapfel, this comparative percentage was 259, 222 and 183% respectively, for the harvest 2000. For 2001, the respective figures were 37, 3, -67, and -26%. The ranking of this percentage among the varieties within the years reflects to a great extent the differences in fruit yield (Tab. 7). Furthermore, yields of 2001 were considerably lower than yields of 2000 (with the exception of IP-Idared) and also alternate bearing was more pronounced in the ORG-plots (Tab. 7). This explains, why Boskoop and Glockenapfel have a lower return in 2001 in ORG-plots than in IP plots. These results for the return of fruit harvest need to be valued against production cost. The organic system required - depending on the variety - 29 to 33% more machinery cost, 72% more pesticide cost, and 28 to 41% more labour cost. Particularities of each variety (such as e.g. a higher extent of hand labour for thinning with Boskoop due to its tendency to alternate bearing) were also reflected in the production cost difference among the varieties. Overall, it appears, that as long as the farmers get a higher price for organic apples than for integrated apples (price difference at present: 90%), this compensates for lower yield, less premium fruits and higher production cost in the ORG system and makes the production of organic apples economically attractive.

In 2001, a similar study was published on a comparative study of organic, integrated and conventional apple production systems, performed in Washington State (USA) between 1994 and 1999 (Reganold et al. 2001). Soil quality, horticultural performance, orchard profitability, environmental quality and energy efficiency were looked at in this study. How do the preliminary results of the Wädenswil study compare to the results of the Washington study? The Washington study was planted with similar planting density as the Wädenswil study. For those parameters, which allow for a comparison between the two studies, many results seem to coincide quite well. Also in the Washington study, organic fruit were firmer, sweeter and less tart than integrated fruit and were more profitable. Yield pattern were less consistent across the years in the Washington study compared to the Wädenswil study, where mainly, organic trees had slightly lower yields. However, the respective Wädenswil data has the drawback of not reflecting the yield potential because of the mice and soil compactation problem. To compare among the two studies the differences in soil quality, ecological performance and energy efficiency, further data analyses is required. It can therefore not yet be concluded whether the Wädenswil study performed similarly in these terms like the Washington study, where the organic system resulted generally better in most of the parameters studied.

## CONCLUSIONS

A complex of mice and soil structure problems caused unsatisfactory growth in the first years of the experiment. Mypex mulch is not suitable for tree strip vegetation management in temperate humid conditions (high rainfall). Due to this problem, yield potential was not reached and yield data must be interpreted with this constraint in mind. However, the experiment was very useful for learning more about the horticultural performance of the two systems, particularly for disease and pest control in both systems. Furthermore, the results addressing fruit quality and soil quality are meaningful, since the primary causes of the growth depression could have been eliminated in 1999. The results may be valued in ecological and horticultural terms. Regarding economical relevance to a grower, the yield-based comparative economic modelling provides a first insight into the scale of importance of the various potential production challenges for a grower in the organic system.

As long as organic fruit enjoys a significant price premium, growers can tolerate yield reduction and may earn considerably more profit. However, price premium assumptions may be tenuous since the increasing quantity of marketed organic apples will put their price under pressure. Differences between varieties were noted mainly regarding disease and pest development, but not for the other parameters measured. Greenness values and flower bud status pointed at a better nutritional status of trees in the integrated system. Nitrogen nutrition in organic apple orchards deserves special attention to avoid alternate bearing. A consistent trend of higher firmness and higher sugar was observed in the organic system. The integrated system produced a higher proportion of apples corresponding to the external quality standards of the market. Regarding internal quality parameters, the observed trend pointed at sweeter and less tart fruit in the organic system. Significant differences were found for soil quality parameters, pointing at a higher biological activity in the organic system. However, the final data analysis needs to confirm these findings.These conclusions require further confirmation by the 2002/2003 data (fruit analyses, sensory analyses, soil analyses). Additional parameters (fruit phenols, fruit nutrients, sensory analyses, biological activity of soils) will complement the data set for final analyses and provide a basis for explaining some of the results.

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## Tables

Table 1. Summary of the apple orchard management in the IP- and ORG-plots of the comparative systems' trial in Wädenswil, Switzerland, 1995-2002.

| Management | Organic (ORG) | Integrated (IP) |
|---|---|---|
| Training | Slender spindle | Slender spindle |
| Fertilization | Biorga NPK (7/3/8) 58 kg/ha before and after flowering, Rhizinus chips (40 kg N), compost | 50 kg N/ha with Ammoniumnitrate 27% 200 kg/ha, before flowering, Landor PKMg (10/30/3) 200 kg/ha in March |
| Thinning | By hand | α-Naphthylacetamide (NAAm) at end of flowering |
| Ground cover management | Mulching, tree-stripe: Mypex mulch 1995-99, afterwards: 4x tilling (April/May/July/Aug), 4x additional hand tillings | Mulching, tree-stripe: Mypex mulch 1995-99, afterwards: before flowering (April): 1x Glyphosate and Inspire; after flowering (June): 1x Basta; 2x tilling (July/Aug) |
| Disease | Copper (0-1x), Sulphur (6-11x), from 2000: clay (2x) (total of 9-11 applications) | Registered products, resistance management |
| Pesticides | Mating disruption, GV (1-4x), Neem (1x), Parexan (1x), soap (0-1x) | Registered products, resistance management |

Table 2. Parameters measured in the IP- and ORG-plots of the comparative apple systems' trial in Wädenswil, Switzerland, 1995-2002.

| Criterion | Parameters |
|---|---|
| Horticultural performance | |
| Vegetative and generative tree growth | Trunk girth, flower density index, 1998/99 flower bud analysis (see Fankhauser et al. 1999 and Dolega et al. 2002) (Boskoop, Resi), greenness (SPAD) |
| Yield and fruit quality | At harvest: kg / tree (quality I, II, cider), firmness<br>*Conservation 2-4°C, ~90%rh*<br>After conservation (4 month+): sugar, acidity, firmness<br>2001/2: sensory analysis [1], nutrient analyses [1], phenols (Idared, Resi) [1] |
| Crop protection (pests and diseases) | Scab, powdery mildew, fungal infections on harvested fruit<br>Rosy and green apple aphid, codling moths, other torticides<br>Red spider mite, rust mite, predatory mite |
| Consumer taste preference | 2001 and 2002 [1] |
| Soil quality | |
| Soil | Microbial C & N; July 2001 $N_{min}$; P, K, Ca, Mg (AAcEDTA, $H_2O$), OM |
| Orchard profitability | |
| Economy | Monitoring of activities(diary; per cumulated plots of each variety)<br>Input monitoring, economical modelling (profit) |
| Environmental quality and energy efficiency | |
| Crop protection | Monitoring of number and quantity of pesticide input [1] |
| Energy use | Monitoring of number and duration of energy dependent management practices [1] |
| Environmental impact rating | Based on index system: optional [1] |

[1] Data not yet available and/or analysed for this publication.

Table 3. SPAD-values in August 2001 in IP- and ORG-plots of the comparative apple production systems' trial in Wädenswil, Switzerland.

| Variety | System | SPAD-Value |
|---|---|---|
| Resi | IP | 45.98 a |
| | ORG | 42.11 b |
| Idared | IP | 51.48 a |
| | ORG | 47.51 b |
| Boskoop | IP | 46.85 a |
| | ORG | 42.04 b |
| Glockenapfel | IP | 47.20 a |
| | ORG | 43.37 b |

Values of the same variety with the same letter are not significantly different (LSD-test, P=0.05).
13./14. Aug. 2001;6 trees/block, 10 leaves/tree.

Table 4. Proportion of fruits meeting first class market standards (%) in the comparative apple production systems' trial in Wädenswil, Switzerland.

| Variety | System | 1999 | 2000 | 2001 |
|---|---|---|---|---|
| Resi | IP | 75 | 91 | 85 |
| | ORG | 80 | 71 | 76 |
| Idared | IP | 57 | 52 | 72 |
| | ORG | 52 | 62 | 68 |
| Boskoop | IP | 46 | 66 | 59 |
| | ORG | 35 | 71 | 55 |
| Glockenapfel | IP | 68 | 79 | 54 |
| | ORG | 80 | 45 | 41 |

Table 5. Comparison of parameters of internal fruit quality in the comparative apple production systems' trial in Wädenswil, Switzerland.

| Variety | System | Firmness (kg/cm²) | | Sugar (Brix) | Acidity (g/l) |
|---|---|---|---|---|---|
| | | At harvest | After storage | | |
| 2000 | | | | | |
| Resi | IP | 7.32 b | 6.22 b | 11.53 b | 6.32 |
| | ORG | 8.19 a | 6.63 a | 12.17 a | 6.27 |
| Idared | IP | 6.40 | 4.58 | 12.53 b | 6.07 a |
| | ORG | 6.65 | 4.81 | 11.59 a | 5.12 b |
| Boskoop | IP | 8.60 | 4.56 | 12.52 | 7.24 |
| | ORG | 8.54 | 4.48 | 12.46 | 6.91 |
| Glockenapfel | IP | 9.14 | 5.44 b | 12.19 | 8.57 a |
| | ORG | 9.39 | 5.92 a | 12.52 | 7.69 b |
| 2001 | | | | | |
| Resi | IP | 8.13 | 7.38 | 13.04 | 6.64 |
| | ORG | 8.45 | 7.56 | 12.91 | 6.95 |
| Idared | IP | 6.62 b | 4.91 b | 12.40 | 6.19 |
| | ORG | 7.33 a | 5.64 a | 12.29 | 6.70 |
| Boskoop | IP | - | - | - | - |
| | ORG | - | - | - | - |
| Glockenapfel | IP | 10.16 b | 6.23 b | 13.60 | 11.43 |
| | ORG | 11.15 a | 6.85 a | 13.53 | 11.33 |

Values of the same variety followed by the same letter are not significantly different (LSD-test, P=0.05). Four samples of 10 fruits ea.

Table 6. Effect of system on selected soil properties using two extraction methods for mineral elements, 2001.

| Parameter | Effect | |
|---|---|---|
| Organic matter (%) | ORG>IP | |
| Mineral element (extraction method) | ($H_2$0-extraction) | (Ammonium acetate EDTA-extraction) |
| K | ORG>IP | ORG>IP |
| P | interaction production system x replicate block significant | - |
| Ca | ORG>IP | - |
| Ca | - | interaction production system x replicate block significant |
| Mg | ORG>IP | ORG>IP |
| Mg | - | interaction variety x production system significant |

Table 7. Yields and estimated profit (price x fresh fruit yield) 1999-2001 of ORG- and IP-system in the comparative systems' trial in Wädenswil, Switzerland. )

| | **PI** | | | **ORG** | | |
|---|---|---|---|---|---|---|
| **Yield** (kg/ha) | 1999 | 2000 | 2001 | 1999 | 2000 | 2001 |
| Resi | 8774 | 15498 | 9178 | 8886 | 13272 | 6030 |
| Idared | 11990 | 19528 | 22700 | 11030 | 23560 | 12258 |
| Glockenapfel | 7984 | 23576 | 12142 | 6680 | 20032 | 4200 |
| Boskoop | 11124 | 26852 | 8080 | 5350 | 27080 | 1162 |
| **Profit** (CHF) | 1999 | 2000 | 2001 | 1999 | 2000 | 2001 |
| Resi | 6800 | 13251 | 7572 | 15817 | 22828 | 10372 |
| Idared | 9592 | 15622 | 17252 | 16324 | 40523 | 17774 |
| Glockenapfel | 6387 | 18861 | 9714 | 11490 | 34455 | 7224 |
| Boskoop | 7008 | 19602 | 5656 | 8774 | 43578 | 1894 |

## Figures


Fig. 1. Split plot-design of the field experiment.

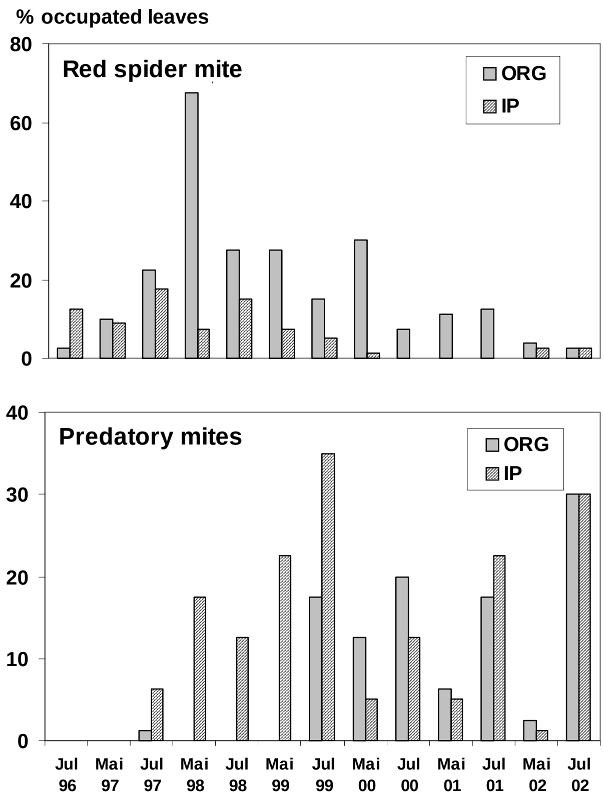


Fig. 2. Red spider mite (*Panonychus ulmi*) and predatory mite (*Typhlodromus pyri*) populations in IP- and ORG-plots in Wädenswil, 1998-2002.

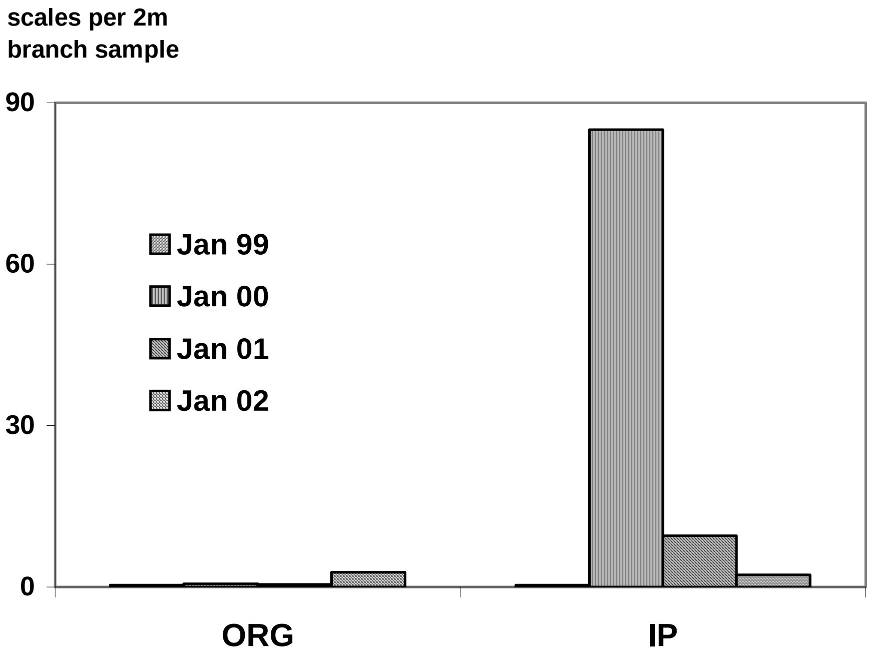


Fig. 3. European fruit scale (*Eulecanium comi*) in IP- and ORG-plots in Wädenswil (branch samples 199-2002).

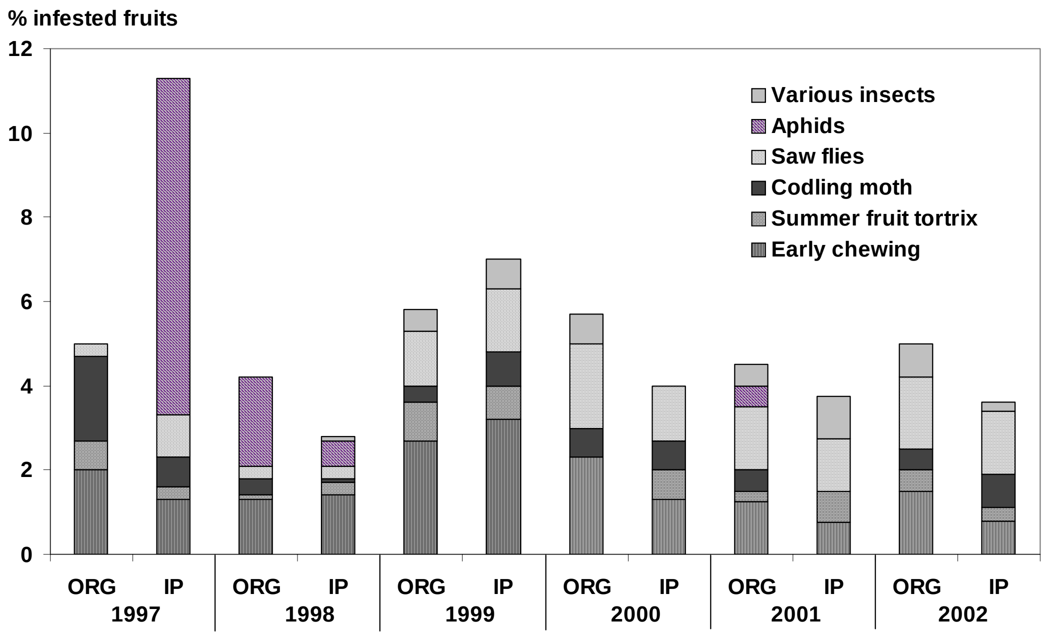


Fig. 4. Cumulated fruit damage (pre-harvest) by various pests in IP- and ORG-plots in Wädenswil, 1997-2001.

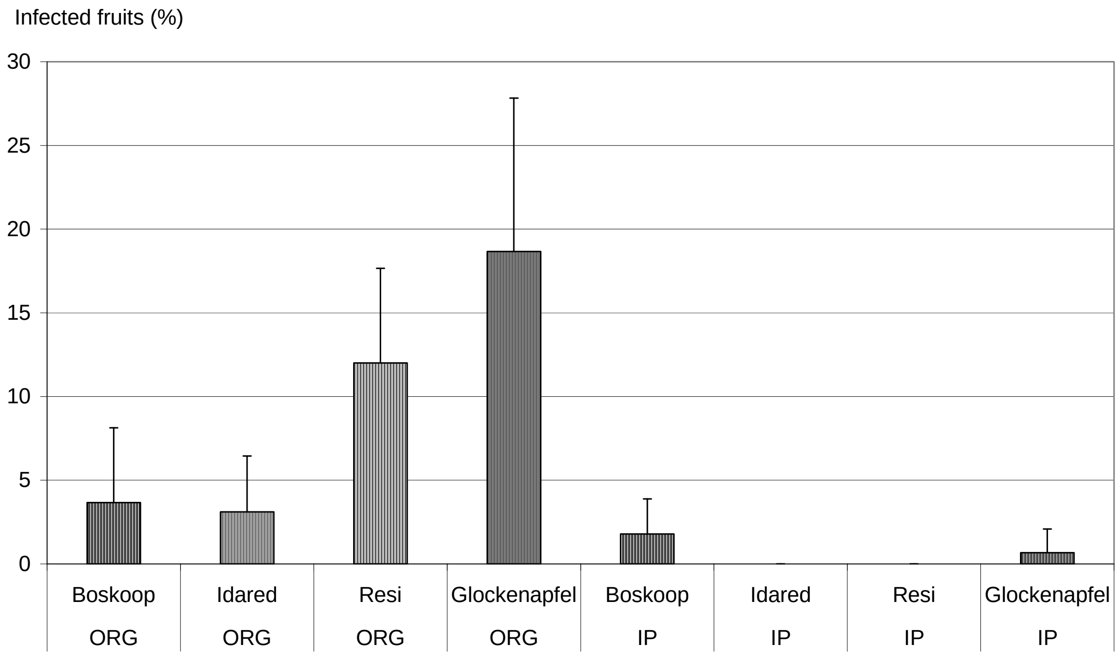


Fig. 5. Calyx rot (*Botryotinia fuckeliana*) on June 21, 2001 in IP- and ORG-plots in Wädenswil, 1997-2001. Disease protection was as follows: IP: IP: 2 x Delan, 2 x Chorus, 3 x Myco-Sin, 2 x Score- Top+Captan+Sulphur, 1 x Flint, 2 x Captan+Nimrod, 2 x Folpet; ORG: 1 x Copper 2 x Myco-San, 3 x Myco-Sin, 8 x sulphur (0.3 %).

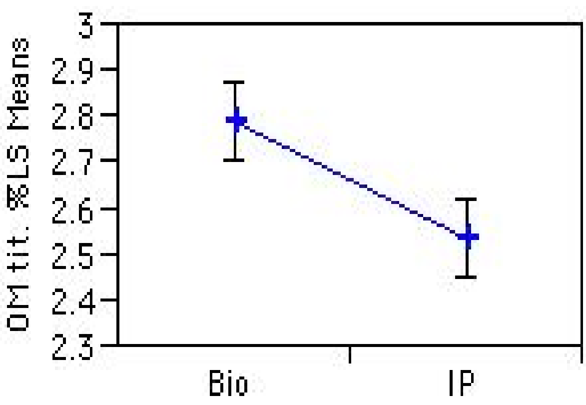


Fig. 6. Comparison of organic matter in IP- and ORG-plots in Wädenswil, 2001.