# Testing the effect of a rainproof protection net on the apple production regarding disease and pest damages

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**Abstract**

*In a field trial within the CORE Organic project DOMINO, the effect of a rain protection combined with an insect net ("Keep in touch – Antiacqua") was tested for organic apple production. The Keep in touch system without any spray from the blooming on was compared to an uncovered and unsprayed treatment (control) as well as an uncovered and organically sprayed treatment. First results of 2019 show a reduction of rotting diseases incidence under the rain coverage. Furthermore fruits will be evaluated on storability and occurrence of post-harvest diseases.*

**Keywords:** organic apple production, rain protection, plant protection, diseases, pests

## Introduction

Table apple production requires an intense direct plant protection in order to reach the fruit quality demanded by the market. The plant protection is primarily used against fungi (apple scab, sooty blotch etc.) and pests (codling moth, aphids etc.). One approach to reduce the application of plant protection products in intensive organic apple orchards is the use of a physical barrier to protect the trees and fruits against rain and insects. Using a rain coverage is expected to reduce fungal infections as most fungi need a water film to infect the plant. Rain cover protections are tested for organic apricot and plum production to protect the trees from fungal and bacterial infections. Furthermore, the use of a rain coverage combined with insect nets is widely used for organic cherry production to protect both from rain and from insects. For apple production, however, the use of rain protections and insect nets is little explored. Only anti-hail nets are commonly used for apple production so far. Therefore, in this study, a weather protection has been tested that combines a film for rain protection above the trees with an insect net on the side. The weather protection tested, marketed as "Keep in touch – Antiacqua" system, is a single-row weather protection. In this study the net of the weather protection system was rolled out up to the ground, including the soil in the enclosed area.

## Material and Methods

The trial was conducted in an organically managed apple orchard at FiBL in Frick (Switzerland, 350 m.a.s.l., around 1000 mm precipitation per year). Three treatments were tested: a "Keep in touch" treatment, an "organic" treatment, and a "control". For the "Keep in touch" treatment, the protective system was opened (i.e. the trees were covered) during full flowering (phenological stage BBCH 65) (Figure 3), and from this point in time no more plant protection products (PPT) were used for that treatment. The "organic" treatment was managed in the same way as common for a Swiss organic apple orchard, i.e. without rain coverage with PPT, and in the "control" no rain protection and no PPT were used. The trial included three repetitions with 5 to 11 trees per repetition and was conducted for the two apple cultivars Topaz and Ariwa.

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The disease incidence of apple scab in mid-July was assessed using a scoring from 1 (= 0% visible symptoms) to 9 (> 90% visible symptoms) (Patocchi *et al.*, 2009). At harvest, the incidence of diseases (apple scab, sooty blotch, lenticel rot and other rotting diseases), physiological disorders (bitter pit, underdeveloped fruits), and pest damages on fruits (aphid damage, insect feeding damage) was determined. Yield was assessed by weighing the fruits, which were classified into three categories: marketable fruits, fruits for cider production, and waste fruits. Fruit quality was assessed by estimating the percentage of overcolour, and measuring fruit weight and size, sugar content, and firmness for ten fruits per repetition. Samples of fruits of the different treatments are stored in a cold storage at FiBL and it is planned to store the fruits until February 2020 and to assess at this time storage damages on the fruits.

End of April 2019 and end of August 2019 beating samples of the different treatments were taken to assess differences in the composition of arthropods. The samples will later be analysed by the DOMINO project partner INHORT in Poland.

Figure 3: The "Keep in touch - Antiacqua" protection system, an incomplete exclusion net, was opened at full flowering.

**Results**

For both cultivars, Ariwa and Topaz, scab infections were reduced in the “Keep in touch” treatment compared to the “organic” treatment and also compared to the “control”. The level of scab infections was lower for Topaz compared to Ariwa.

The share of marketable fruits was highest for the “Keep in touch” treatment, closely followed by the “organic” treatment, and lowest for the control (Figure 2).

In the “Keep in touch” treatment a decrease in the number of fallen fruits, rotten fruits on the tree, fruits with lenticel rot, fruits with sooty blotch, and fruits with insect feeding damage was observed at harvest. However, the amount of underdeveloped fruits, deformed fruits, and aphid damaged fruits was higher in the “Keep in touch” treatment. No fruit scab was observed in any of the treatments.

Fruit weight, sugar content, and the overcolour were lower for the “Keep in touch” treatment, but no differences in firmness was observed between the treatments. Fruit weight was 13% and 20% lower for Ariwa and Topaz respectively in the “Keep in touch” treatment compared to the control. Overcolour percentage was reduced by around a quarter and sugar content reduced by 18% for both varieties compared to the control. Samples of fruits of the different treatments are stored in a cold storage at FiBL and it is planned to store the fruits until February 2020 and to assess at this time storage damages on the fruits.

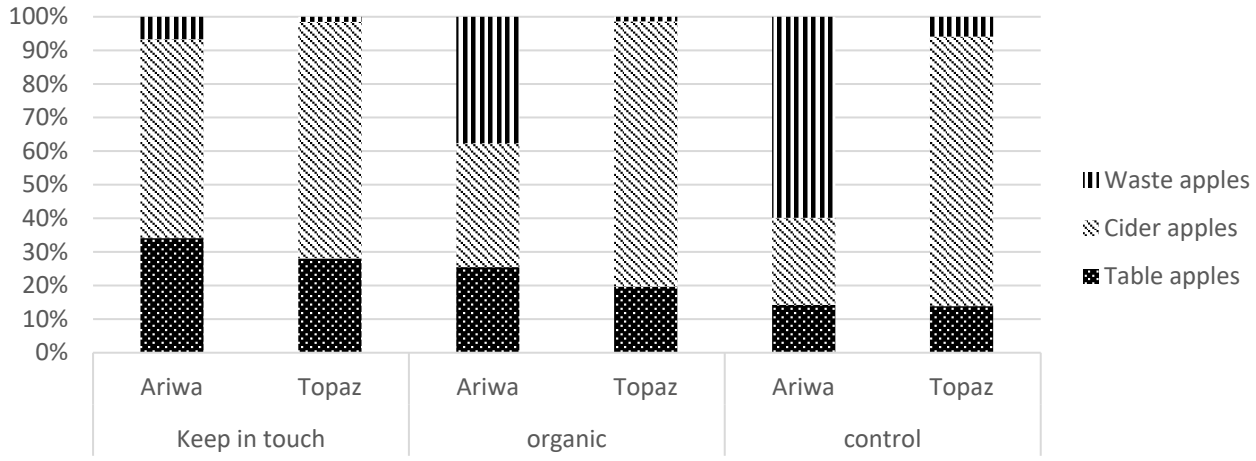


Figure 4: Weight proportion of marketable fruits (table apples), apples for cider production (cider apples), and waste apples for the “Keep in touch” treatment, the “organic” treatment, and the control.

## Discussion

The results of the season 2019 showed that the rain coverage can decrease scab infections as well as fungal diseases on fruits at harvest such as lenticel rot or sooty blotch. Chouinard *et al.* (2019) investigated the effect of a complete row-by-row insect exclusion net (soil excluded, i.e. nets closed above ground) with and without rainproof top for organic apple production, and hypothesizes that fewer microcracks at the surface of fruits – and not a change in humidity – contributed to decrease sooty blotch and flyspeck incidence and severity. Fewer microcracks are also expected to have a positive effect on fruit storability and shelf-life.

Closing the net during full flowering might have a negative effect on the fruit pollination since there was a higher number of underdeveloped and deformed fruits for the “Keep in touch” treatment. Similarly, Chouinard *et al.* (2019) observed a reduced number of seeds produced per fruit in the netted rows. Moreover, Kelderer *et al.* (2014) report a higher number of deformed fruits in plots where nets were installed before flowering as opposed to during bloom. Furthermore, the control of aphids through natural enemies might have been delayed causing more aphid damaged fruits because of excluding beneficial insects from pests (Manja *et al.*, 2019). Other studies report an enhanced development of aphids under netting (Alaphilippe *et al.*, 2016; Aoun, 2016). Chouinard *et al.* (2019) state that a low pressure with pests prior to the enclosure of the trees is required in order to prevent some species with no metamorphosis outside the enclosures from developing high population levels under the protection of nets.

Regarding fruit quality, first results in this study indicate a lower sugar content and lower red overcolour of fruits under rain coverage. These results are in accordance with Chouinard *et al.* (2019), who observed a slowdown of fruit colour and maturation under nets, particularly under rainproof nets (Chouinard *et al.*, 2019). Light and temperature are the two main factors affecting fruit development. Netting is known to alter the microclimate in the orchard by influencing the temperature (decrease or increase depending on the type of net and location), decreasing the solar irradiation and the airflow, and increasing the humidity (Bosančić *et al.*, 2018; Lopez *et al.*, 2018; Mupambi *et al.*, 2018; Manja *et al.*, 2019). The reduced sugar content measured in our study for fruits under netting might indicate a light limitation, and thus less photosynthesis. In apple, the red overcolour is promoted by high light intensity and cool temperatures (Gouws *et al.*, 2014). The reduced overcolour observed in our study might be a consequence of the reduced light intensity combined with the

temperature buffer effect of the coverage (slight cooling during the day, heat preserved during the night). However, the overcolour should be assessed on a higher number of fruits to confirm these results. The firmness was not affected by the coverage, in compliance with the results of Chouinard *et al.* (2019) who observed that firmness varied among years, but not among treatments. Unlike other studies, we found a decrease in fruit weight. Since netting has a thinning effect, it results in a decrease in fruit number and increase in fruit weight (Kelderer *et al.*, 2014; Chouinard *et al.*, 2019).The meta-analysis of Bosančić *et al.* (2018) showed that the effect of netting on fruit quality is cultivar dependent, one factor being the maturation season with an earlier maturation of late-season cultivars under netting. In our study, both varieties (Ariwa and Topaz) have a similar maturation time point, therefore explaining the similar effects of the net on fruit quality.

All the here presented results are from the first season of this trial i.e. from only one year. All the assessments will be repeated in the season 2020 and presumably 2021 to verify the here presented results.

**Acknowledgements**

This trial is part of the CORE Organic project DOMINO. The authors acknowledge the financial support for this project provided by transnational funding bodies, being partners of the H2020 ERA-net project, CORE Organic Cofund, and the cofund from the European Commission.

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