

Agrivoltaics in apple farming – comparing two roof systems and four apple cultivars

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Abstract

In spring of 2022, apple trees grafted on rootstock M9 using the cultivars ‘Freya’, ‘Topaz’, ‘Delcored’ and ‘Natyra®’ were roofed by semi-transparent solar panels mounted on two different substructures – a stationary system fixing the panels at an angle of 10% East-West and a tiltable system giving the possibility to adjust the panels’ alignment within a range of up to 80% towards East or West. A Control plot was covered with grey hail net. Monitored data include floribundity, yield, fruit quality parameters, incidence of pests and diseases and physiological development of the trees. Results will be published when based on two experimental years.

Keywords: agrivoltaics, agrophotovoltaics, agrisolar, sheltered production

Introduction

Agrivoltaics describes the combined production of agricultural crops and solar energy on the same site. This idea addresses several possible advantages, for example the dual-use of the scarce resource land, possible advantages for the crops in the context of climate change adaption and the imperative to enforce a transition to renewable energy sources. However, the impact of this cultivation method on crop management needs analysis. The research presented in this paper is part of a project network of various partners that aims to generate knowledge about the agrivoltaics cultivation of specialized horticultural crops in Southern Germany. For more information visit the website www.agripv-bw.de (up to date only available in German).

Material and Methods

The trial site is located at the Kompetenzzentrum Obstbau Bodensee in Ravensburg, Germany (47°46'00.1"N, 9°33'20.2"E) and consists of 18 rows with 80 trees each. Planting distances are 3.5 m and 0.95 m between and in the rows, respectively. Side rows will not be analysed to avoid border effects. The inner 16 rows were planted in spring 2022 in turns alternating each row with the four cultivars ‘Freya’, ‘Topaz’, ‘Delcored’ and ‘Natyra®’ grafted on rootstock M9. Crossways, the site is roofed by three different systems. The two test systems feature semi-transparent glass-glass solar panels with a light transmission of 49%. Panels are mounted on two different substructures as illustrated in Figure 1 – a stationary system fixing the panels at an angle of 10 % and a tiltable system (“tracker”) with the possibility to adjust the panels’ alignment within a range of up to 80 %. The orientation is approximately towards East-West for both systems. These two treatments are compared to a Control plot covered with grey hail net which reduces the incident radiation by roughly 15 %. Monitored parameters starting in 2023 include floribundity, yield, fruit quality parameters, incidence of pests and diseases and indicators of physiological development of the trees. The input of fungicides in both roofed treatments is reduced compared to the Control plot and will be documented. Parameters describing physiologically relevant aspects, for example water availability at root level, changes in microclimatic conditions and percentage reduction of incident light over the day will be added for the season of 2024. First results will

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be published early in the year 2025 as soon as part of the data will be based on two years of analysis.



Figure 1: Fixed angle (left) and tiltable (right) mounting system equipped with semi-transparent photovoltaic panels.

Results and Discussion

From the first harvest in 2023, some preliminary tendencies can be derived. Compared to the Control plot, the shaded situation led to:

- a better protection from infestation with apple scab and sooty blotch
- a higher percentage of fruit saleable for the fresh market (thus a higher packout)
- a slightly lower overall yield per tree (including apples for fresh market and processing) at least in this first year of trial
- a delay of some days in ripeness and thus in harvest date
- a reduction in average fruit size
- a reduced intensity of over colour for all tested varieties except 'Delcored'
- less growth in stem circumference measured 20 cm above the graft union

To derive valid conclusions, the further development during the next years of trial will be necessary.

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Citation of the full publication

The citation of the full publication will be found on Ecofruit website as soon as available.