Protecting apple trees from rain – better fruit quality and maintenance of yield

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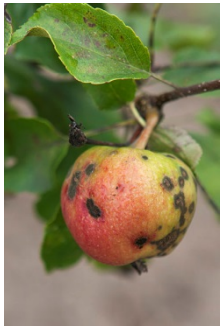
Background

Hypotheses



- The rain shield will reduce the duration of leaf and fruit wetness and inhibit infections by *Venturia inaequlis* causing apple scab

- The rain shields will affect the leaf microclimate and the photosynthetic yield due to reductions in light intensity and wind speed depending on the plastic material

- The outcome in terms of fruit yield and quality will depend on the microclimate of the fruits

Experimental set up

- The apple cultivar ‘Santana’ (*Malus x domestica*) was followed during two summer seasons in 2014 and 2015 (May-September)

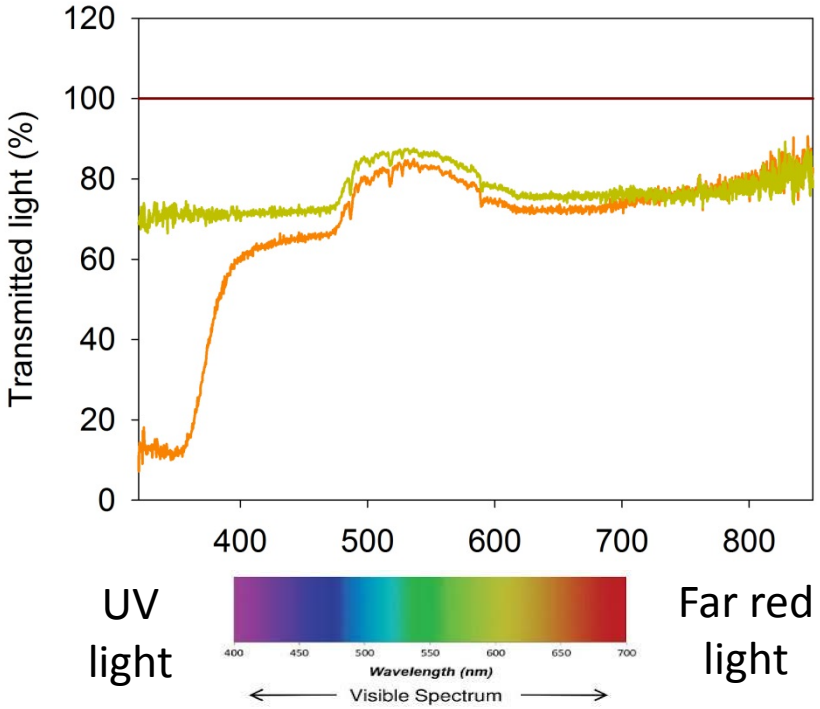
- Four treatments repeated three times
  1- 2. Two control treatments (Unsprayed, Sprayed with sulphur and potasium bicarbonate
  3. Shielded with non UV penetrable plastic (UV-)
  4. Shielded with UV penetrable plastic (UV+)

Measurements

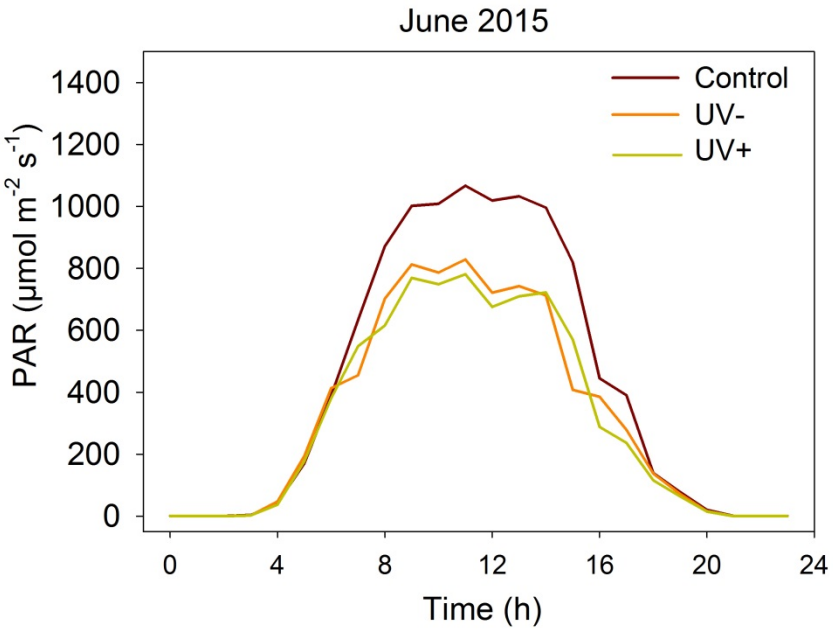
- Climate parameters were meassured continously during the growing season at two weather stations. One placed in the open and the other one placed underneath the shield
- Leaf photosynthetic gas exhange was measured *in situ* from 08:00 h to 20:00 h on three sunny and three cloudy days (5 min intervals)
- Photosynthetic capacity was measured *in situ* in the upper and lower canopy for 10 days in July 2014 and June 2015 using a Monitoring-Pam flourometer.
- Fruit yield, fruit quality and scab infections were recorded at harvest (11.September 2014 and 30.September 2015)

Light

Spectral distribution of transmitted light



Transmitted light in the photosynthetic active area during the day



Climate

Year	Air temp. (°C)	Air humidity (%RH)	Precipitation (mm day^{-1})	Wind speed (m s^{-1} d^{-1})	Sun hours (h)	Global radiation (MJ m^{-2})
2014	16.4	76.4	1.4	3.3	936	2225
2015	15.0	78.5	2.1	3.6	860	2118
	Δ°C	Δ %	Δ mm day^{-1}	Δ m s^{-1} d^{-1}		
2014	0.2 ± 0.01	-1.5 ± 0.1	-1.5 ± 0.3	-0.7 ± 0.1		
2015	0.1 ± 0.2	-1.4 ± 0.1	-1.9 ± 0.6	-0.5 ± 0.1		

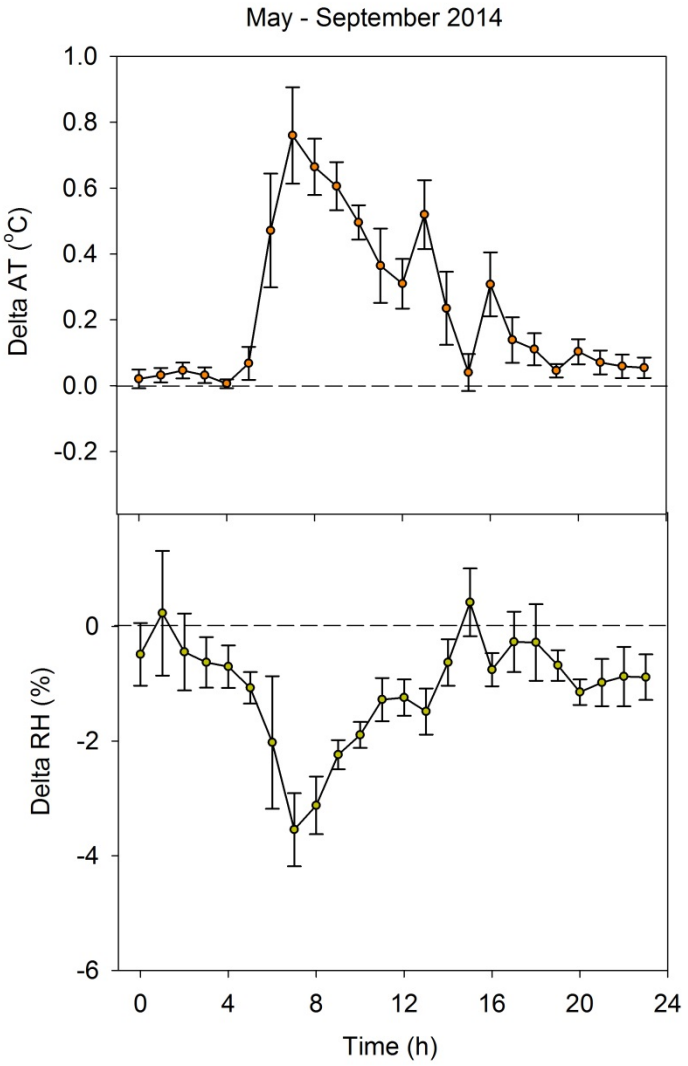
- In 2014 the season was warm and sunny, whereas in 2015 the season was windy and rainy

- The rain shield had similar effects on the microclimate in both years

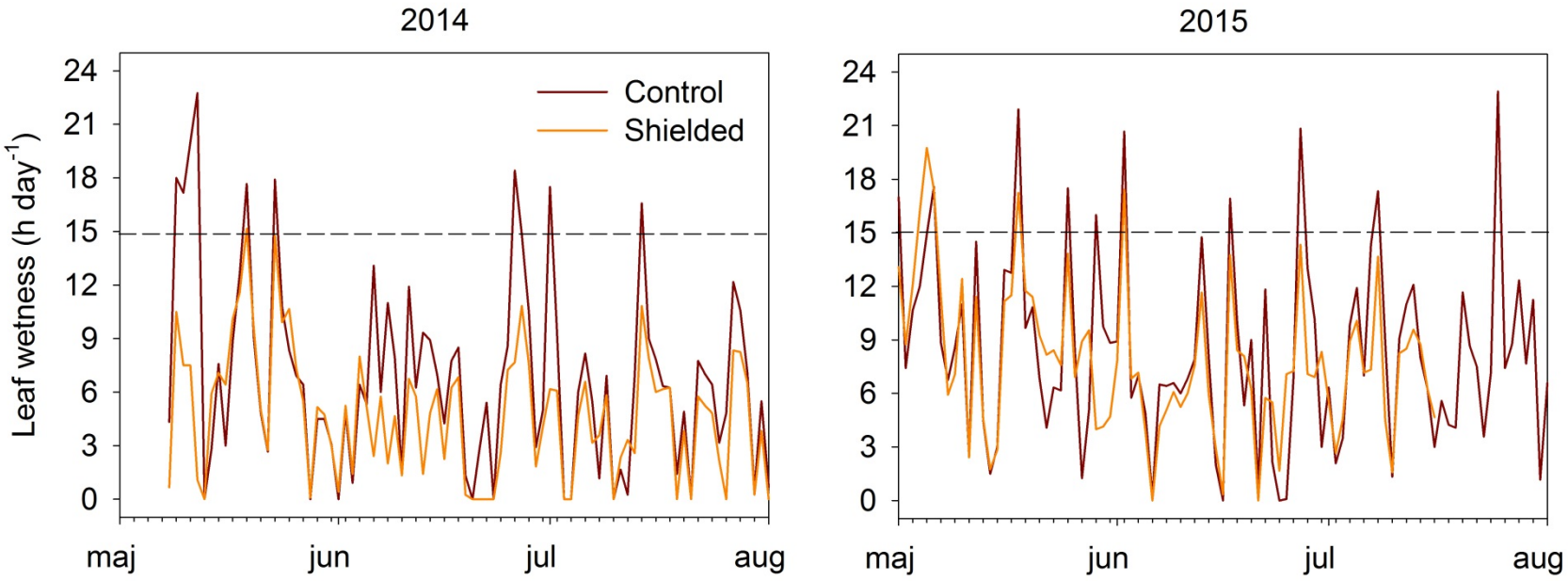
Climate

- The figure shows the effects of the rain shield on the temperature and RH on a diurnal scale (data are from 2014).

- The air temperature was higher and RH was lower underneath the plastic, especially in the morning and midday hours



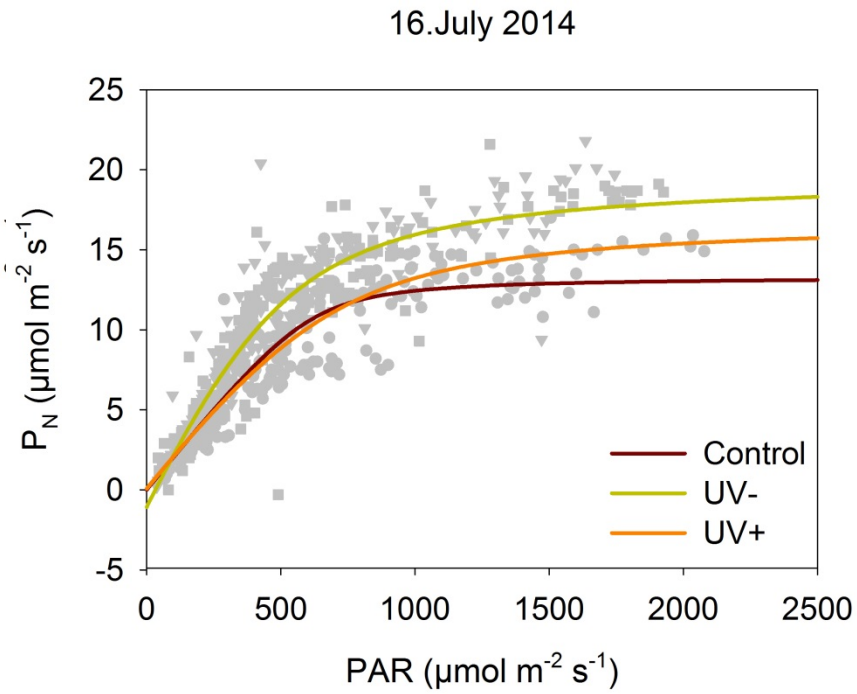
Leaf wetness



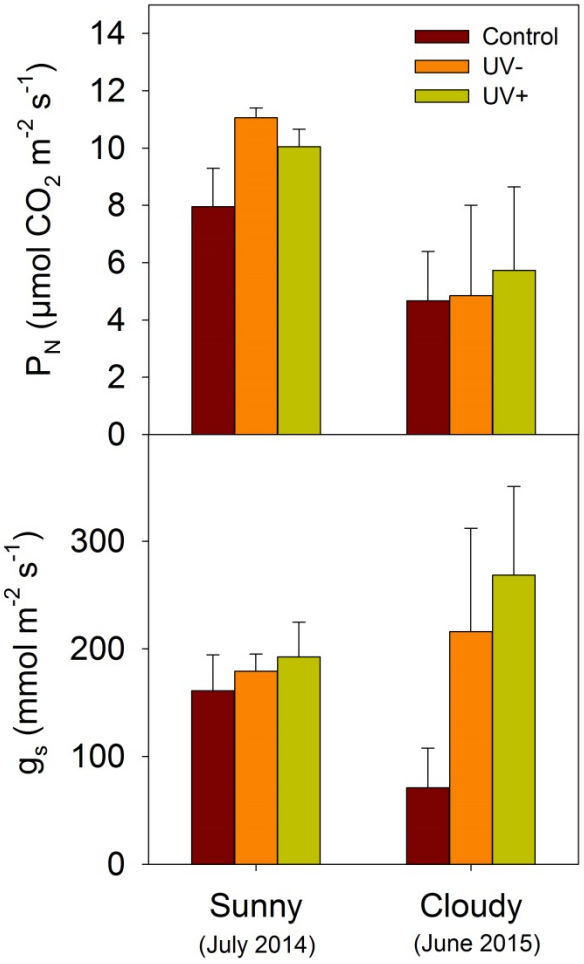
- 15 hours of leaf wetness in warm temperatures is ideal conditions for scab infections caused by the fungus *Venturia inaequalis*

- The number of days with over 15 hours of leaf wetness
  - Was higher in spring 2015 compared to spring 2014
  - Ocurred more often in the control compared with the shielded treatment

Photosynthesis measurements in the upper canopy

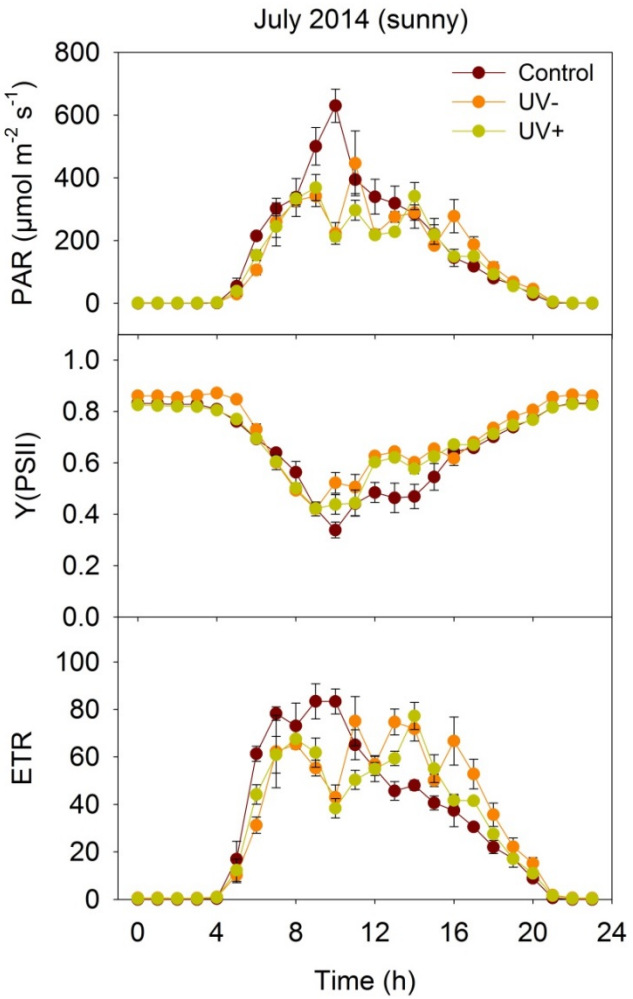


Photosynthesis during sunny and cloudy days



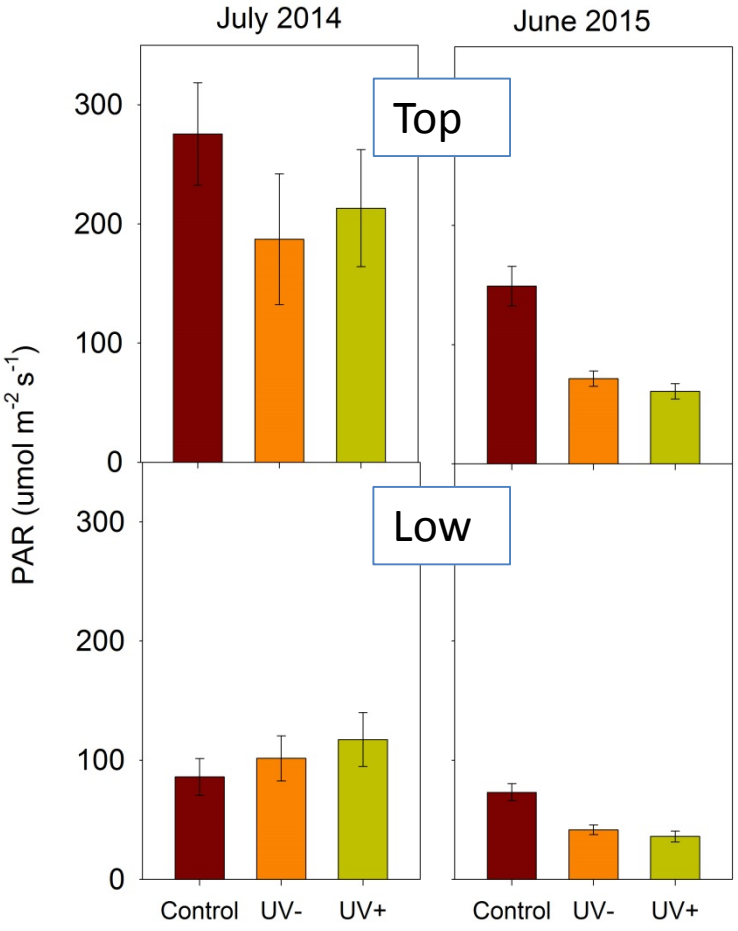
- The daily net photosynthesis was reduced in the control treatment in comparison to leaves protected by the rain shield on sunny days
- There was no effect on the daily net photosynthesis on cloudy days
- Stomatal conductance (g_s) was affected in june 2015, possibly due to increased spraying

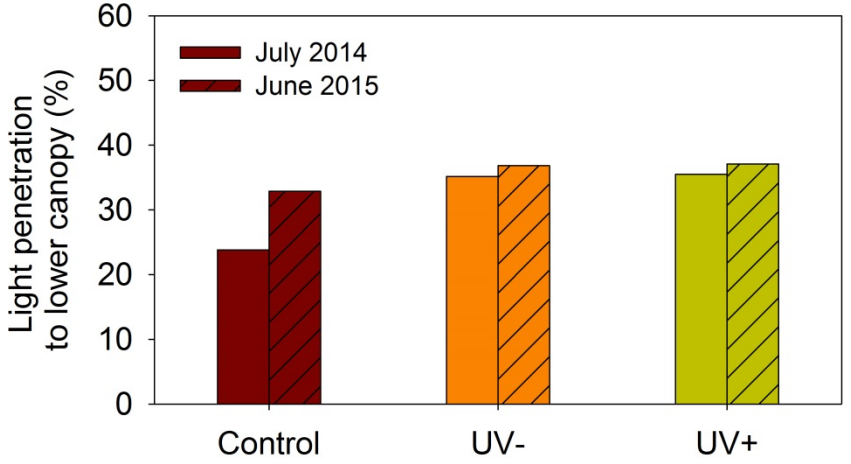
Photosynthetic capacity on sunny days



- High light in combination with high temperature (25-30 °C) reduce the quantum yield (Y) and the electron transport rate (ETR) more in trees not protected by rain shields
- Afternoon depression of photosynthesis is avoided leaves protected by rain shields

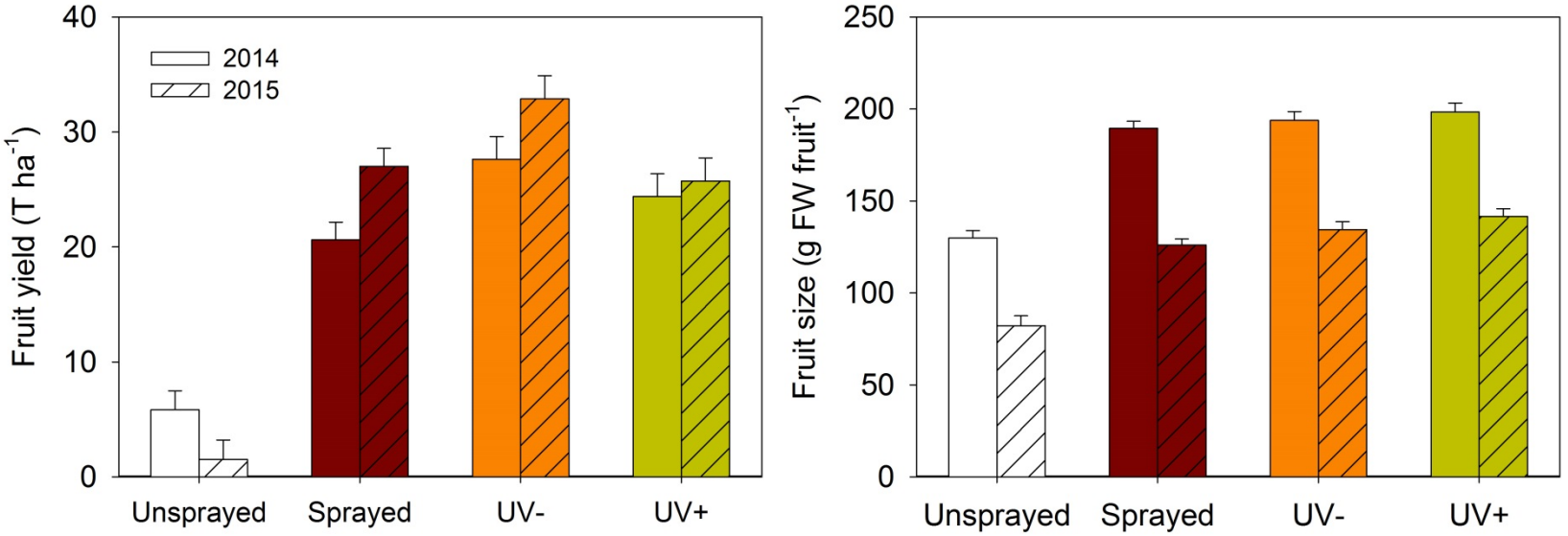
Light penetration in the canopy during sunny and cloudy days





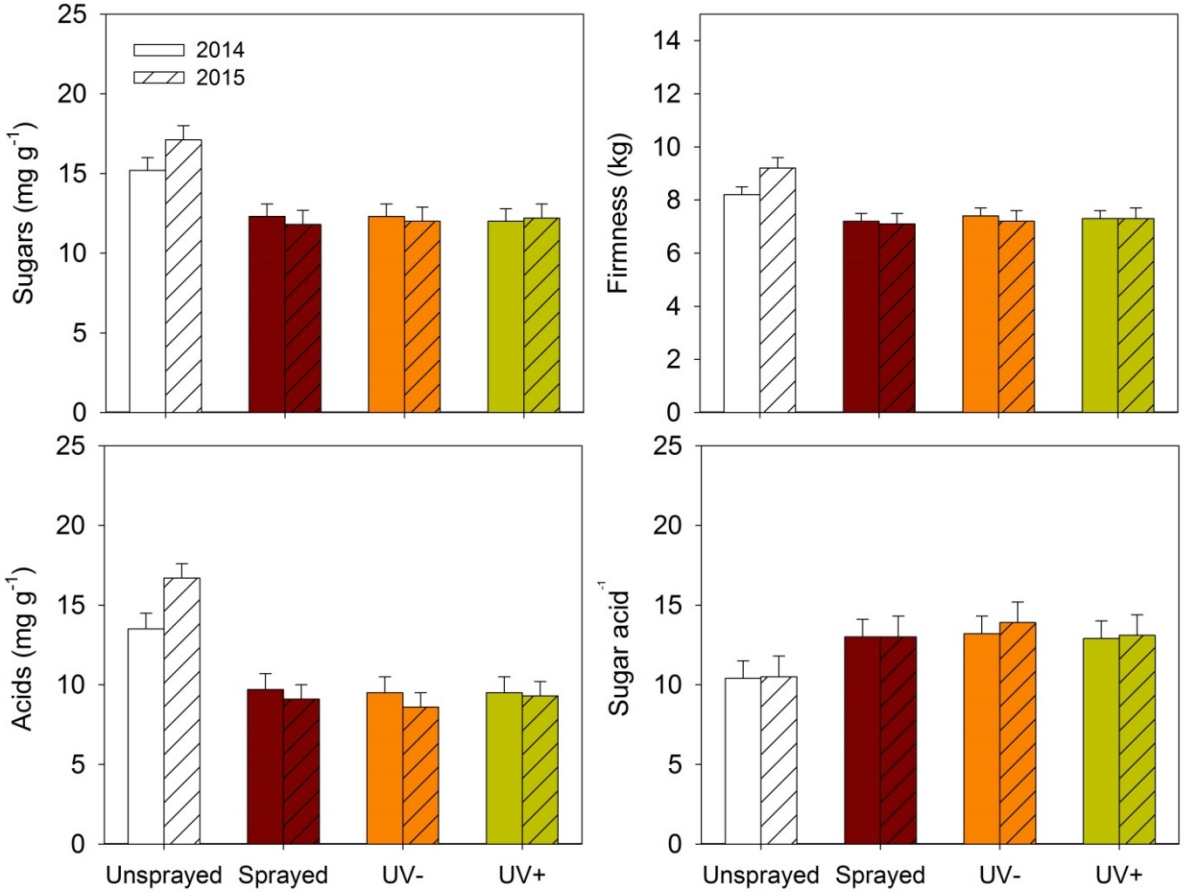
- On sunny days less light penetrates to the lower canopy in trees not protected by rain shields

Fruit yield



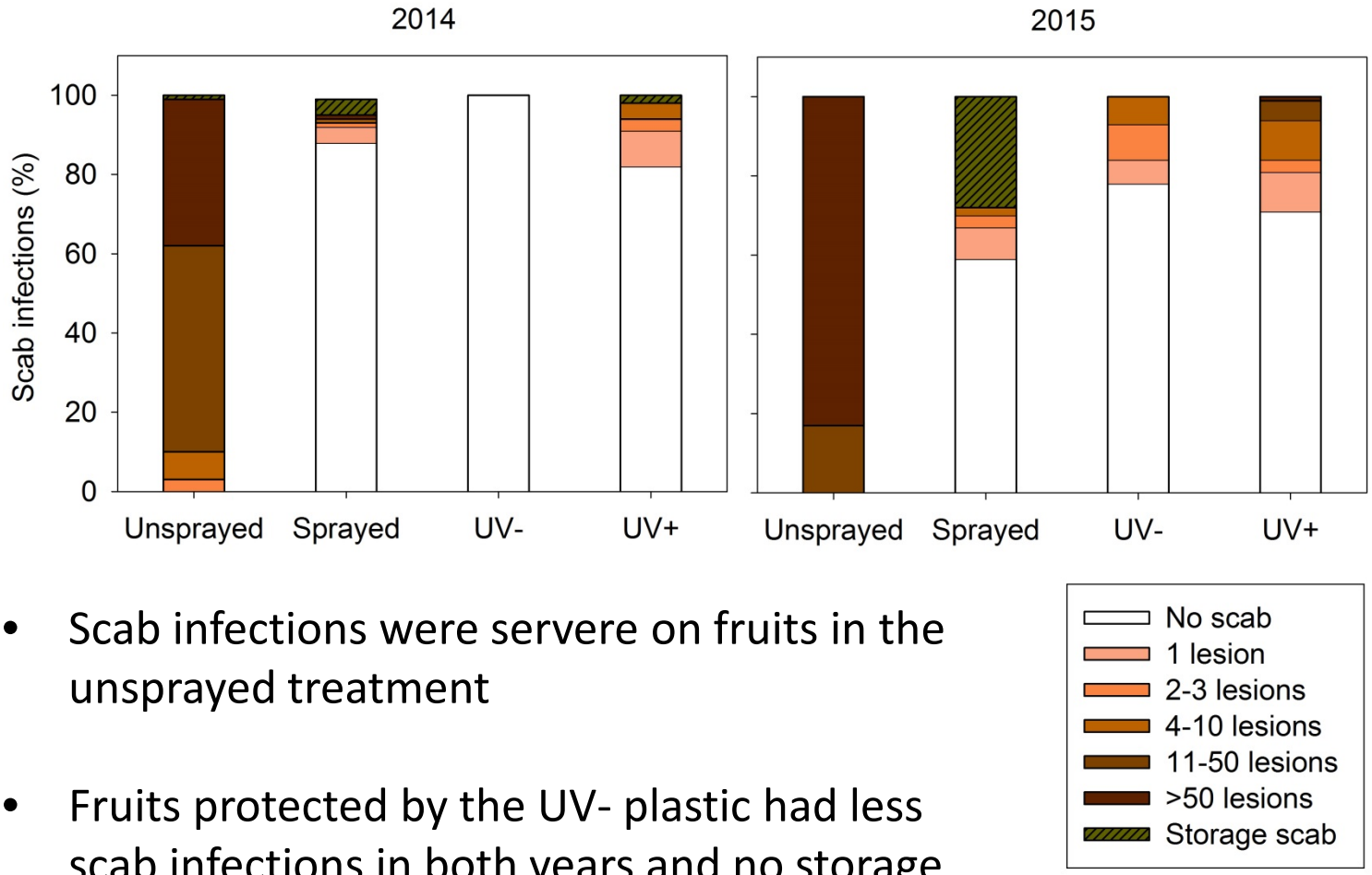
- The fruit yield (Tons ha^{-1}) was increased by spraying or shielding the trees, with a significantly positive of the UV- plastic in comparison to the UV+ plastic
- There were no differences in fruit size between sprayed and shielded treatments

Fruit quality



- The smaller apples in the unsprayed treatment had higher sugar content, but were more firm and less sweet due to an imbalance in the sugar/acid ratio
- No differences were seen between sprayed and shielded treatments

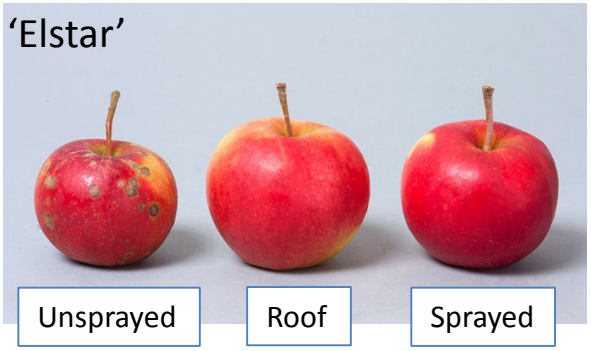
Scab infections on fruits

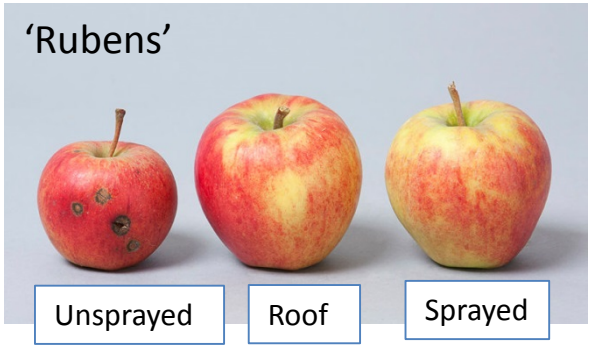


- Scab infections were servere on fruits in the unsprayed treatment
- Fruits protected by the UV- plastic had less scab infections in both years and no storage scab

Conclusion

1. Rain shields are a good alternative strategy to spraying in organic apple orchards and maintains fruit yield and quality





2. The rain shields protects the leaves and the fruits from fungal infections by lowering the number of hours of leaf wetness, with possible additive effects of lower humidity, increased temperature and lower windspeed

3. The rain shields protects the photosynthetic apparatus from high solar irradiance during warm and sunny days avoiding afternoon depression and maintaning the light penetration to the lower canopy

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More challenges!
Pear (Clara frijs)/commercialisation

Effect of shielding on russeting in pear (‘Concorde’)

Shielded Unshielded