

# 3rd European Conference on Copper in Plant Protection

15<sup>th</sup>-16<sup>th</sup> November in Berlin, Germany





# Use of rain roof systems for disease regulation in organic apple production

# Copper reduction projects

## Several projects on the topic „copper reduction/replacement“

### Direct regulation measures

- Testing new products for direct regulation of different diseases

### Indirect regulation measures

- Sanitary measures
- Rain roof systems
- Resistent varieties, etc...

overall strategy – combination of different measures

## Temporary roofing within BÖLN-Projekt „ Sooty blotch“



Sooty blotch



Neofabraea

- First experience with temporary roofing
- different periods with rainroof to identify important infection periods of sooty blotch



# Preliminary Tests

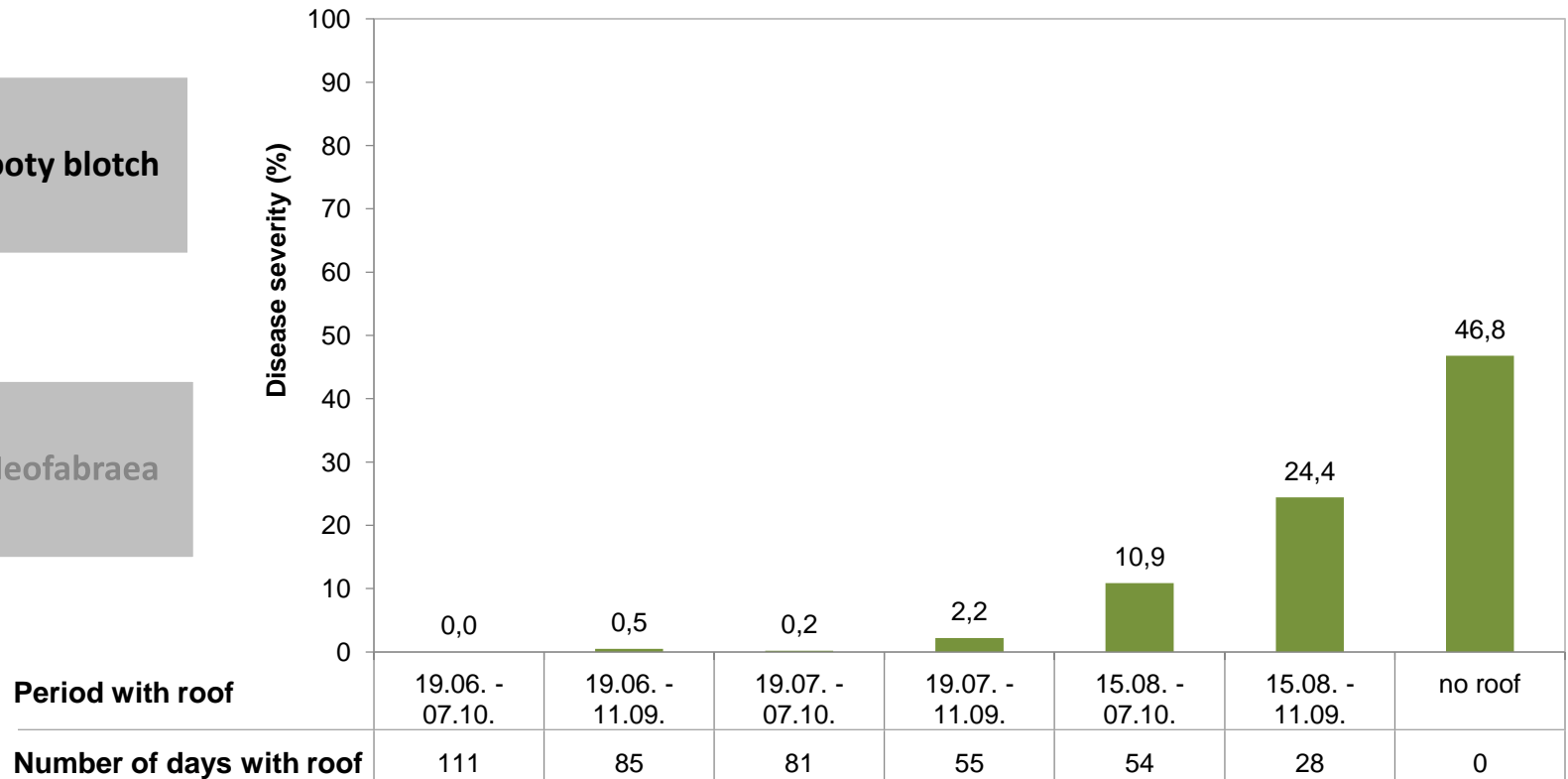
## Temporary roofing 2013 – Sooty blotch



Sooty blotch



Neofabraea



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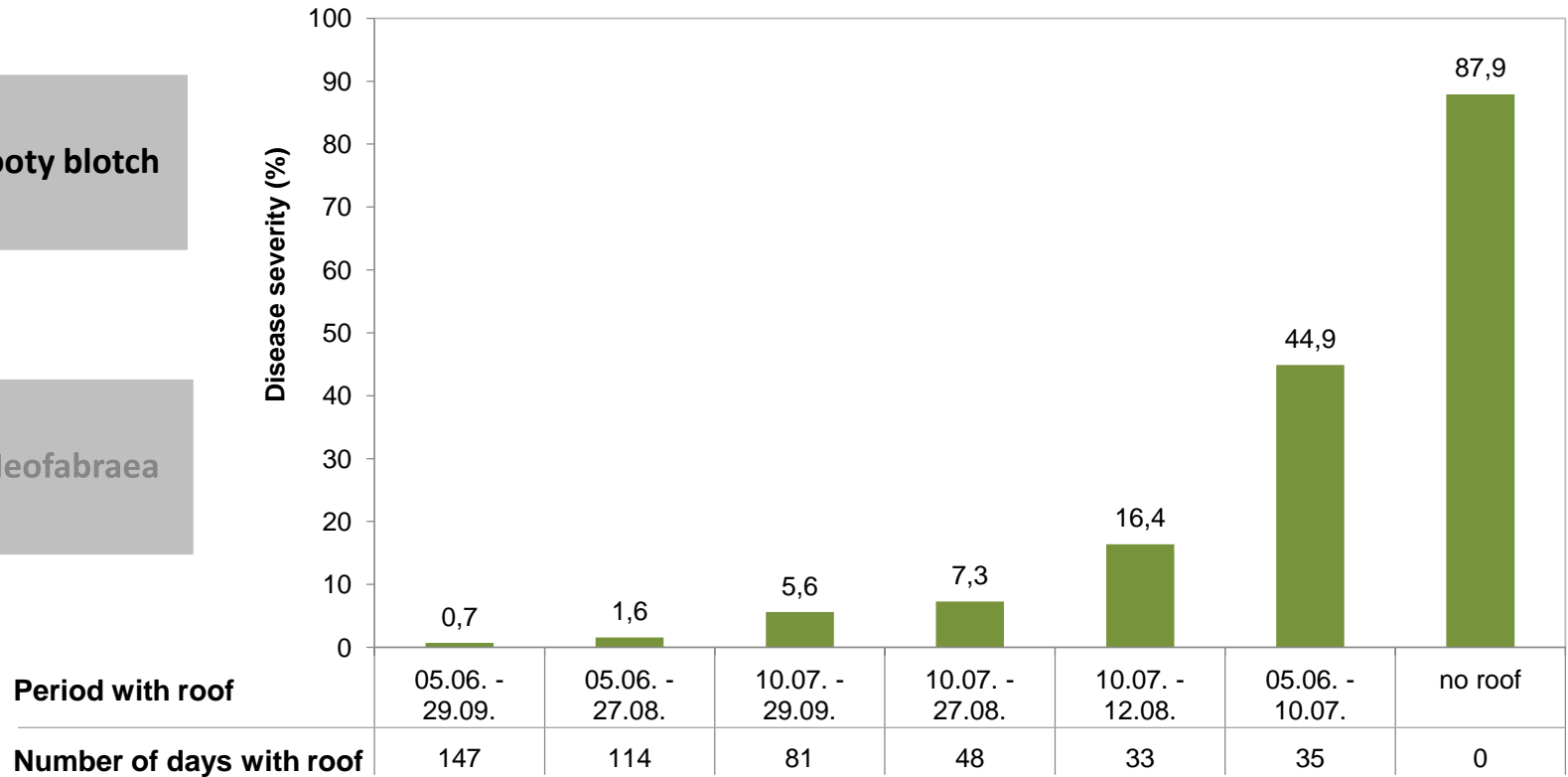
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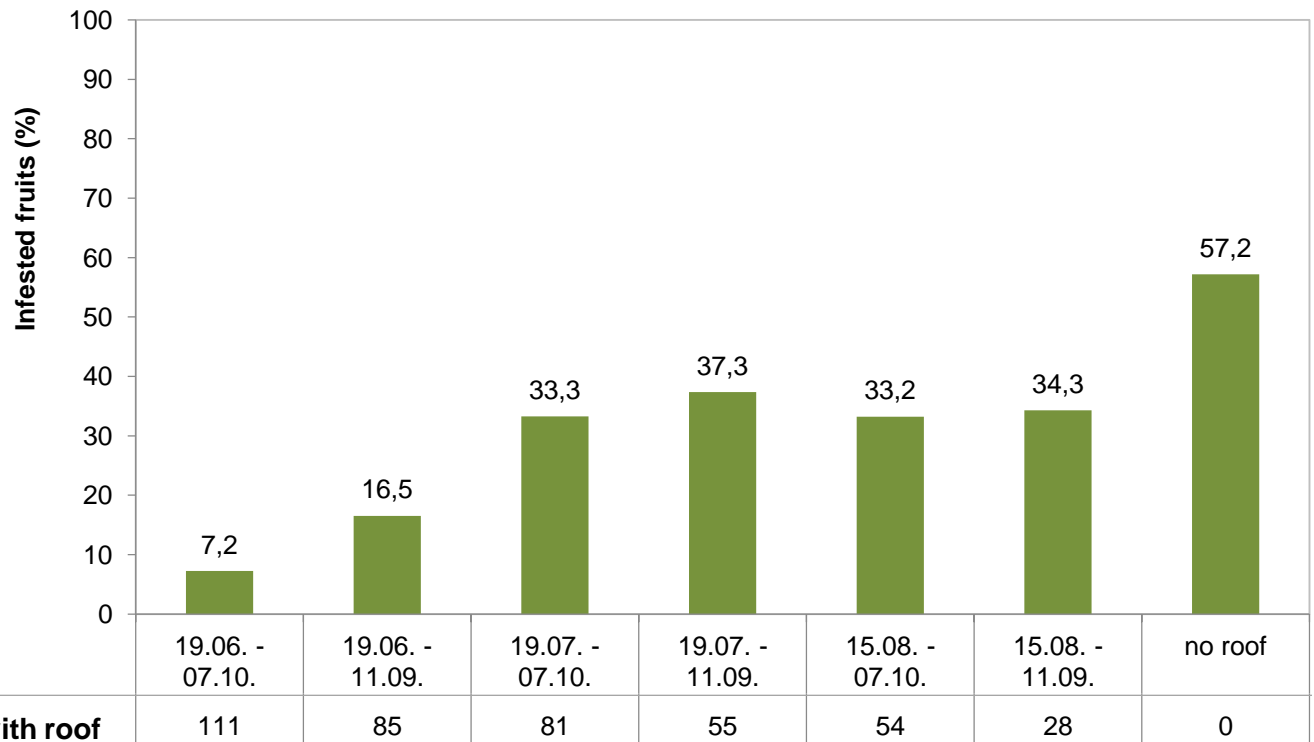
## Temporary roofing 2013 - Neofabraea



Sooty blotch



Neofabraea



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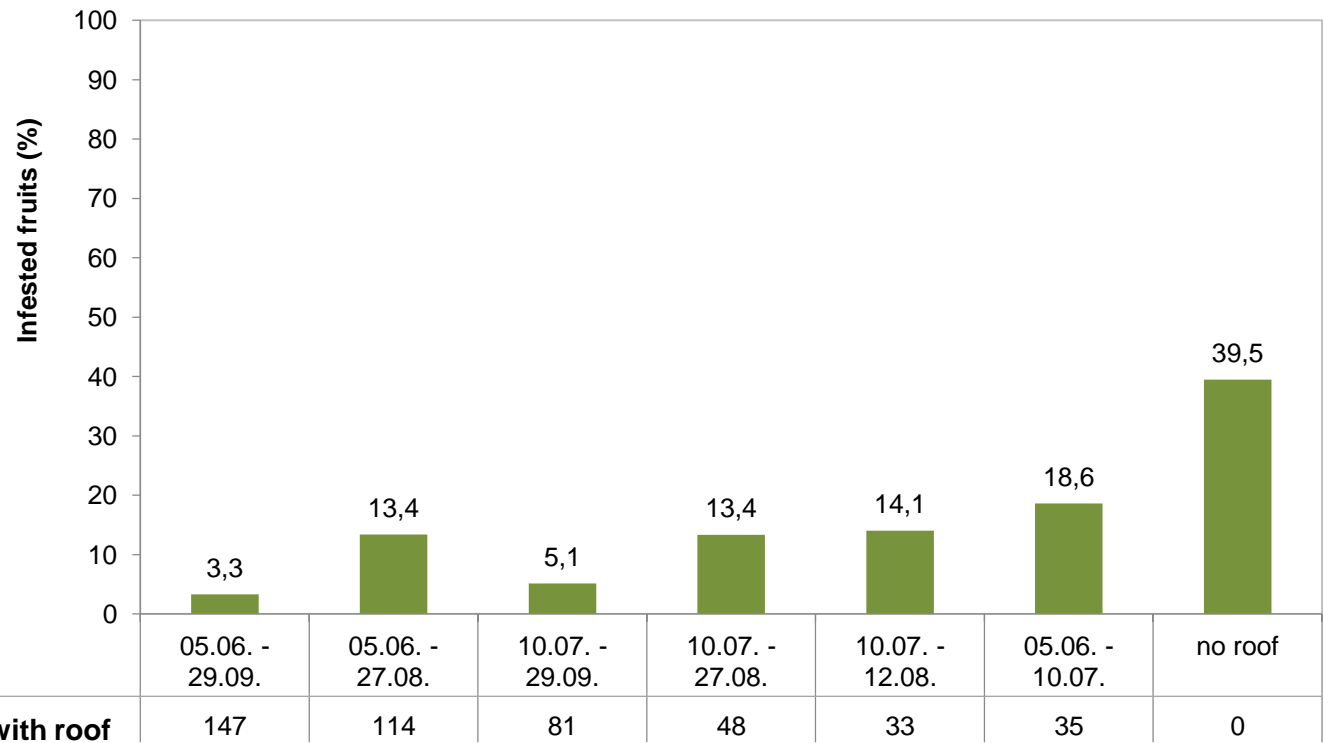
## Temporary roofing 2014 – Neofabraea



Sooty blotch



Neofabraea





# Sheltered cultivation of organic apples

Since 2014:

New trial with permanent rain roof (march till october) and additional net at the side of the orchard



## Sheltered cultivation of organic apples

- Orchard planted in 2013 (0,7 ha)
- About 1700 trees of the variety „Topaz“ on M9
- Certified organic production



### Goal:

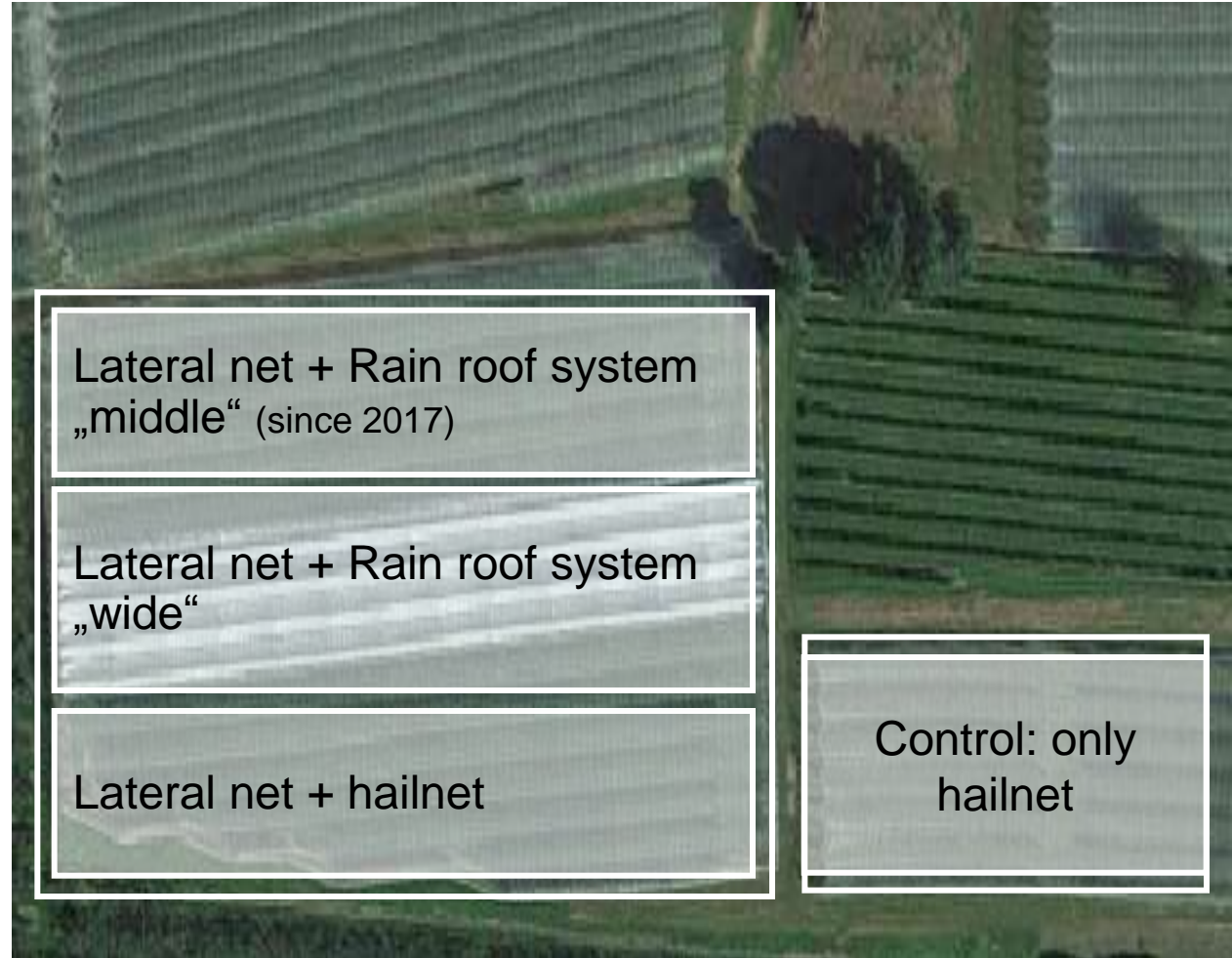
Reduced plant protection input by the use of rain roof systems and net at the side

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Reduced plant protection input by the use of rain roof systems and net at the side



# Sheltered cultivation of organic apples

Lateral net (0,6 ha) + hailnet



# Sheltered cultivation of organic apples

Rain roof system „wide“. 4 x 115 trees



# Sheltered cultivation of organic apples

Rain roof system „middle“. 4 x 115 trees



# Sheltered cultivation of organic apples

Overview treatments:

Treatment	Shelter-system	Plant protection
1 (control)	Hailnet	common plant protection (insecticides and fungicides as usual)
2	Hailnet + lateral net	reduced input of insecticides, common fungicide treatments
3	Rain roof plastic sheet wide + hailnet + lateral net	reduced input of insecticides and fungicides
4	Rain roof plastic sheet middle + hailnet + lateral net	reduced input of insecticides and fungicides

# Reduction of fungicide input



Reduction

year	reduction of fungicide applications with rain roof system wide
2015	60%
2016	92%
2017	87%
2018	93%

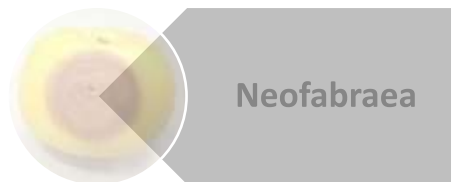
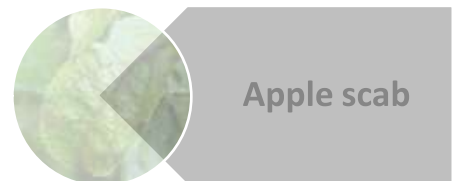
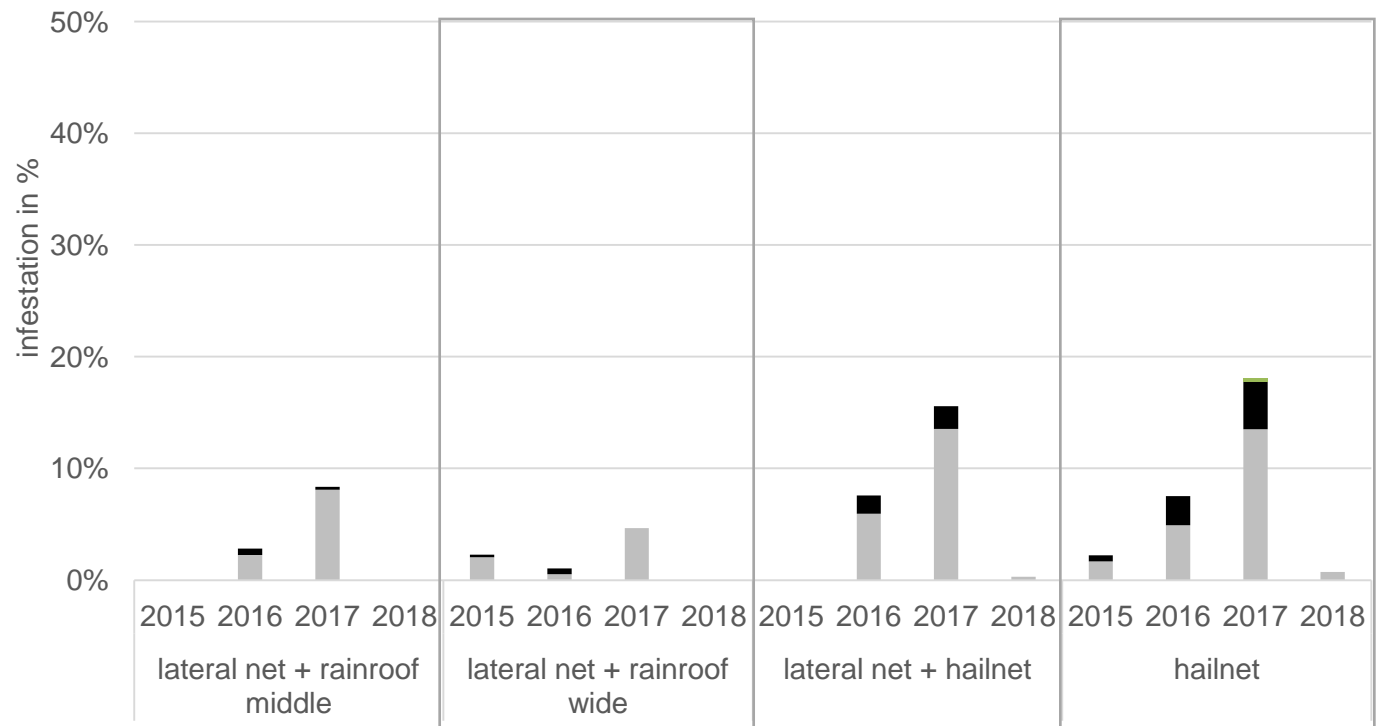


# Effect of rain roof system on infestation with major diseases

Infestation **Sooty Blotch** over years

n=760  
sd=σ

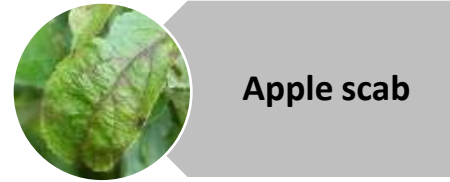
■ 26-50% ■ 11- 25% ■ 5-10% ■ 1-5%



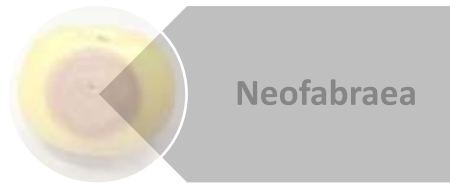
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Sooty blotch

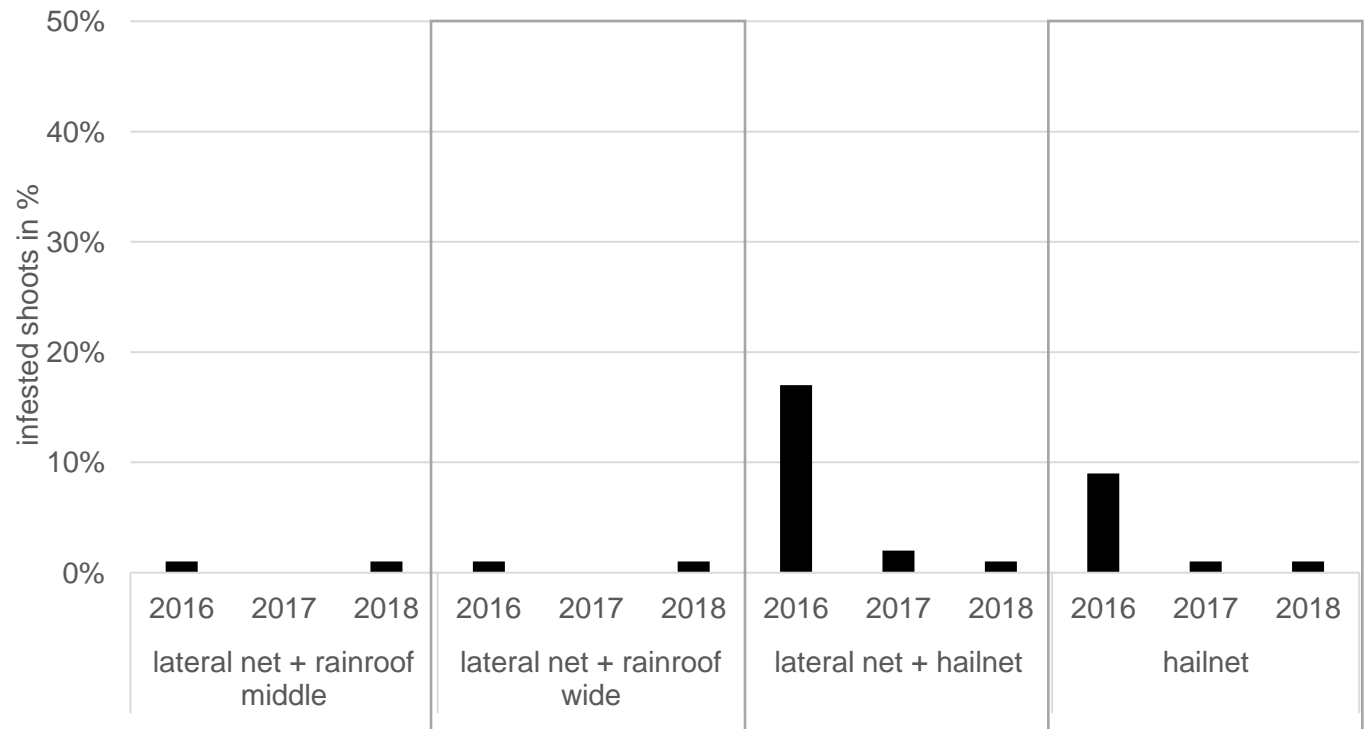


Apple scab



Neofabraea

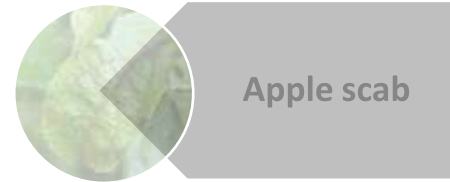
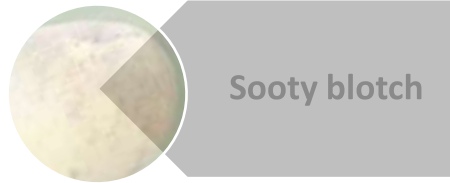
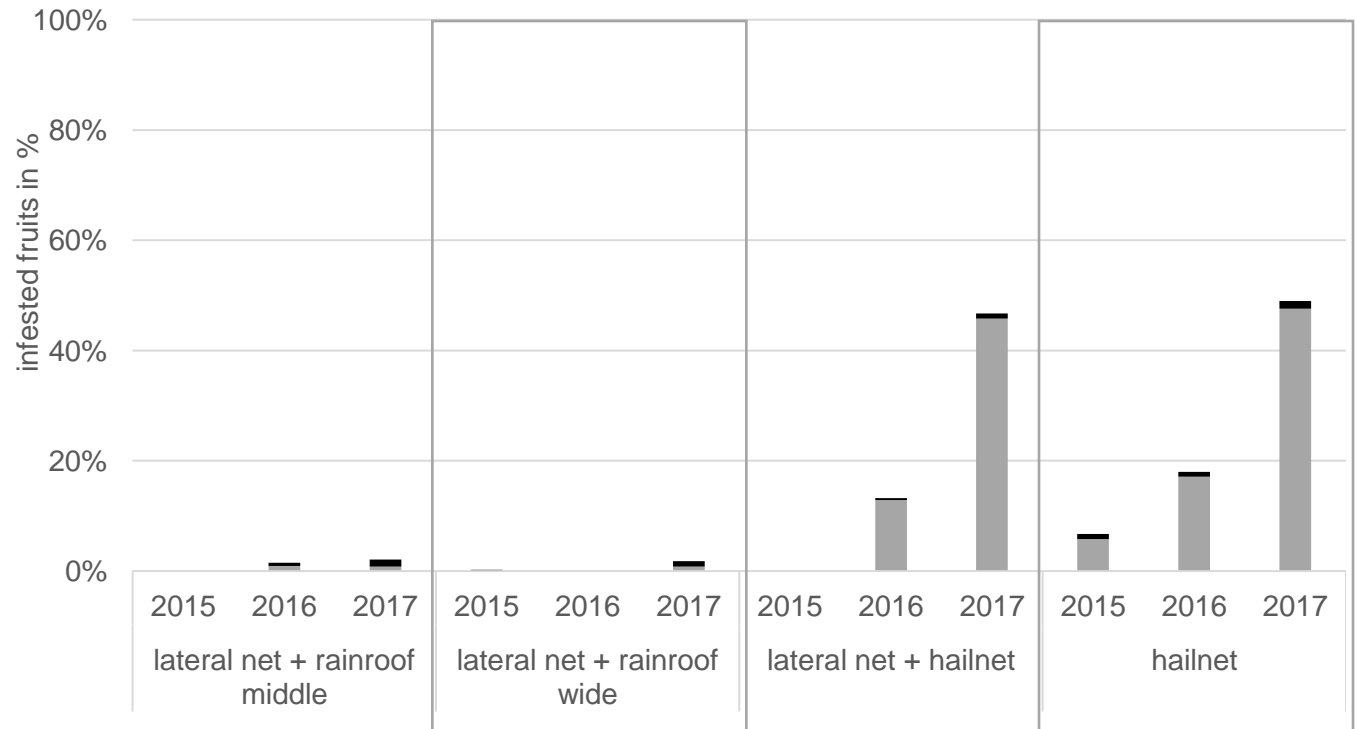
Apple scab - infested shoots (100 shoots per treatment)



# Effect of rain roof system on infestation with major diseases

**Storage diseases** - determined after 4 months cold storage at 2°C

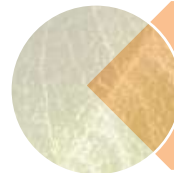
■ other storage diseases ■ Neofabraea



# Effect of rain roof system on several pests



**Woolly apple aphid**  
(*Eriosoma lanigerum*)



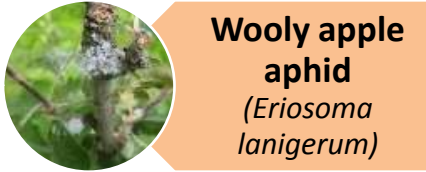
**Apple rust mite**  
(*Aculus schlechtendali*)



**Spider mite**  
(*Panonychus ulmi*)



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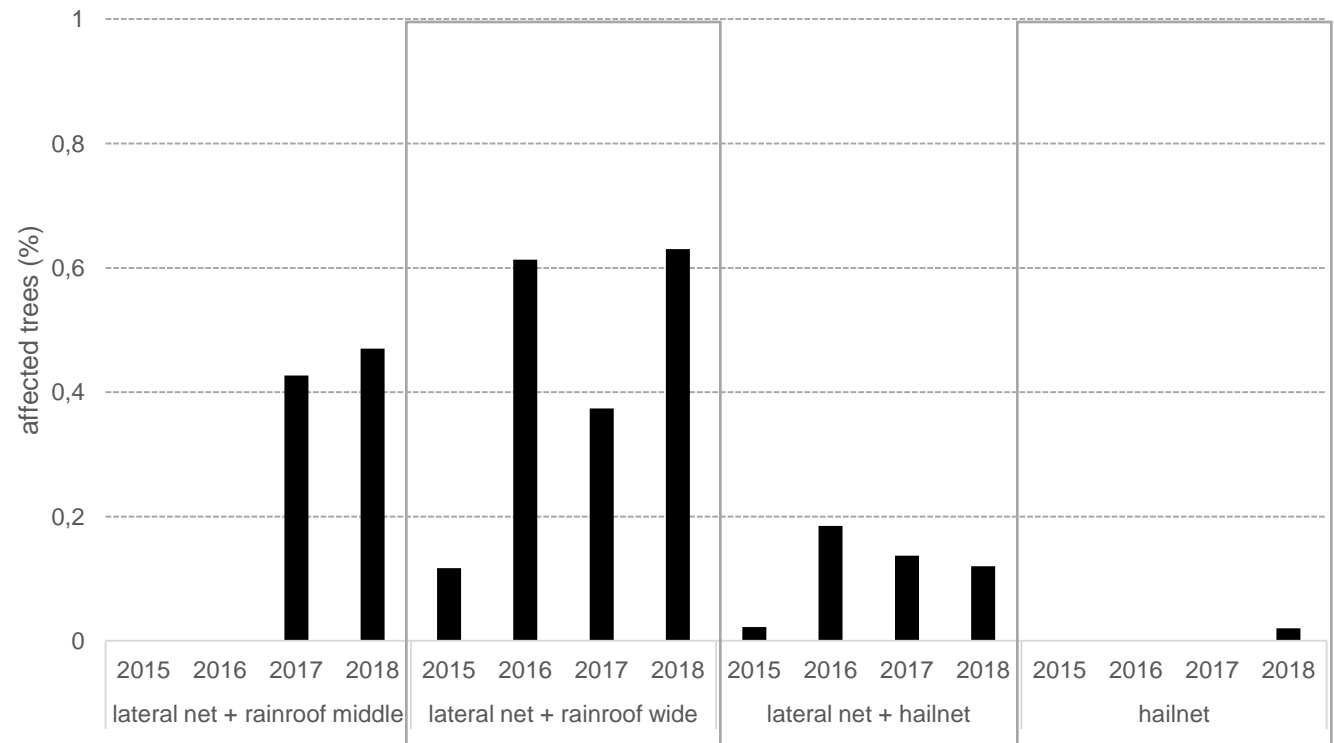


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Woolly apple aphid - affected trees (%)




# Effect of rain roof system on several pests



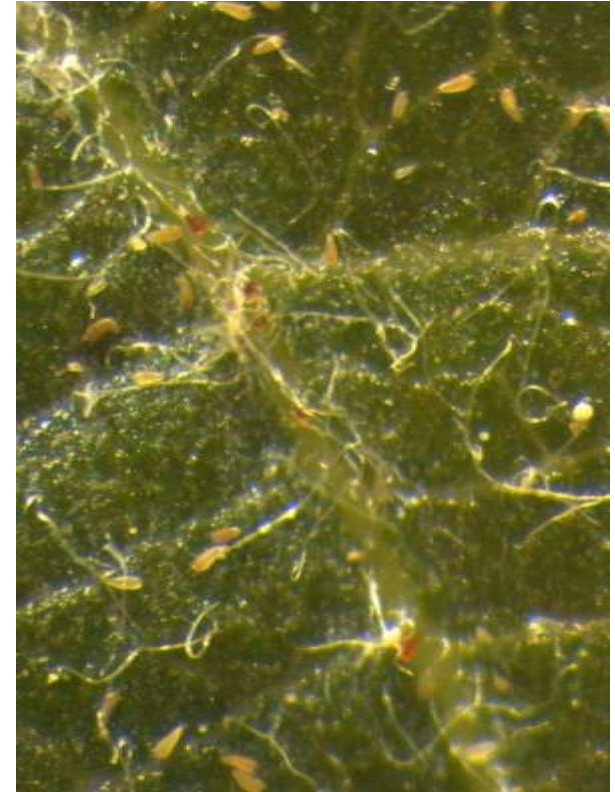
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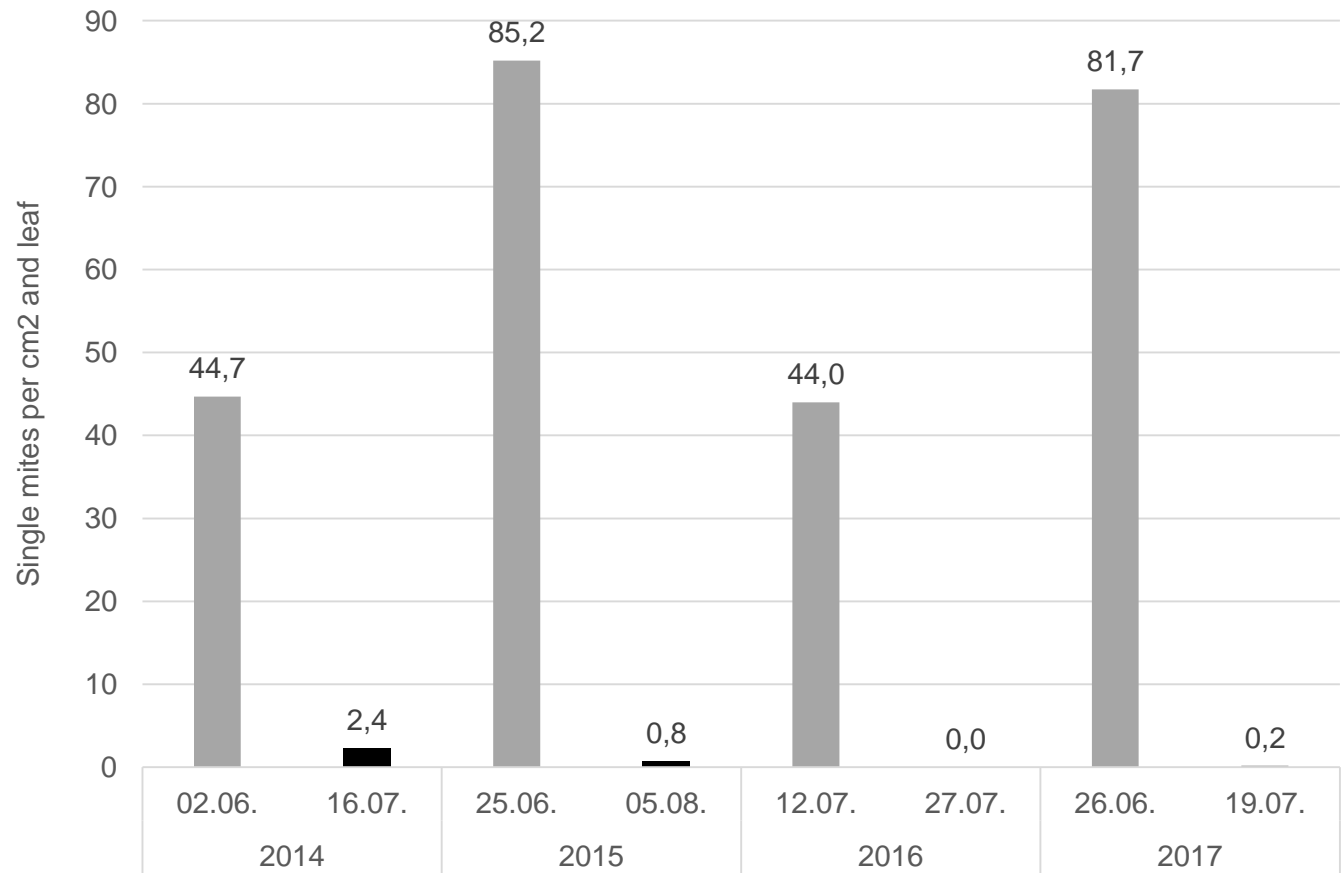


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# Effect of rain roof system on several pests

Rain roof system "wide"



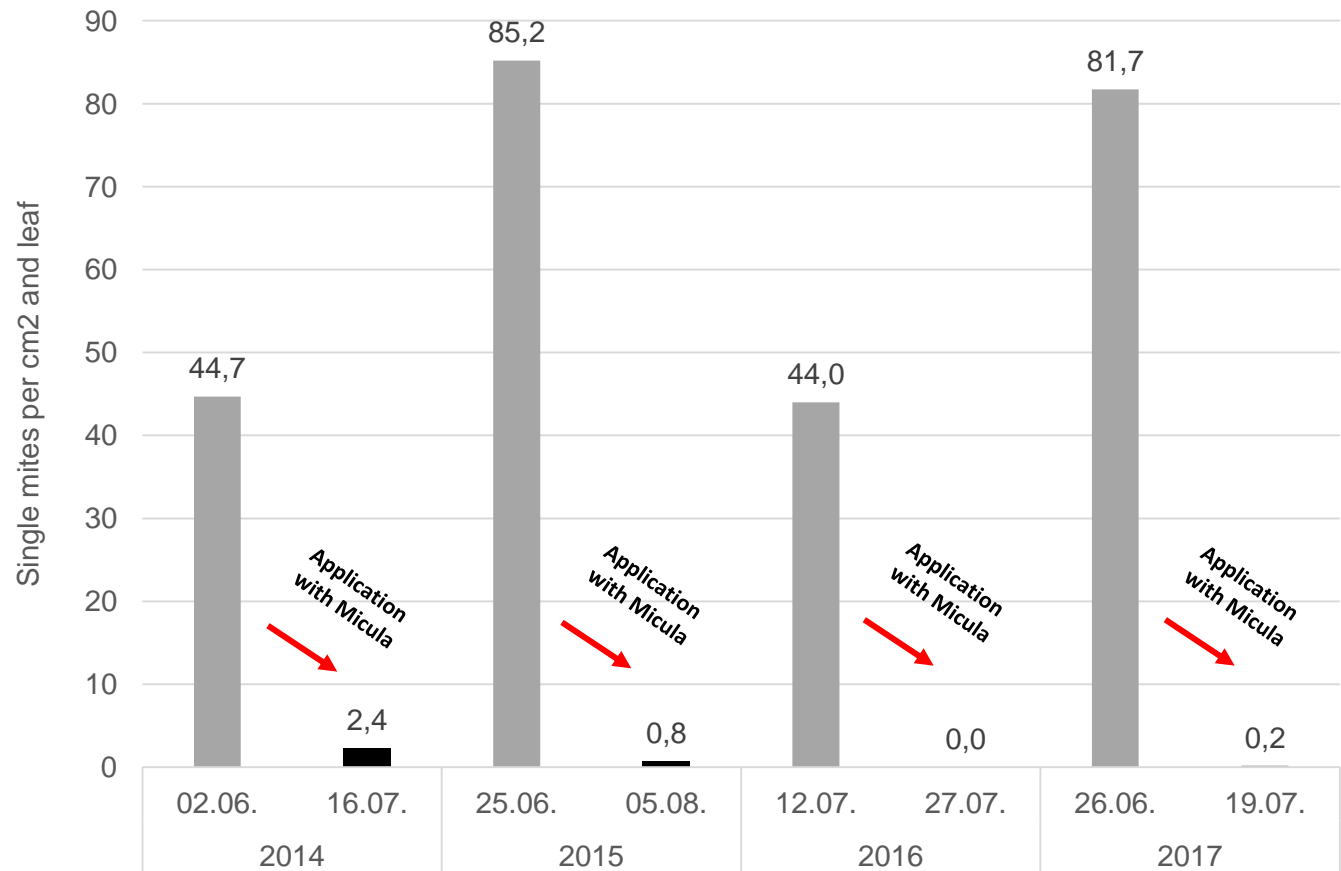
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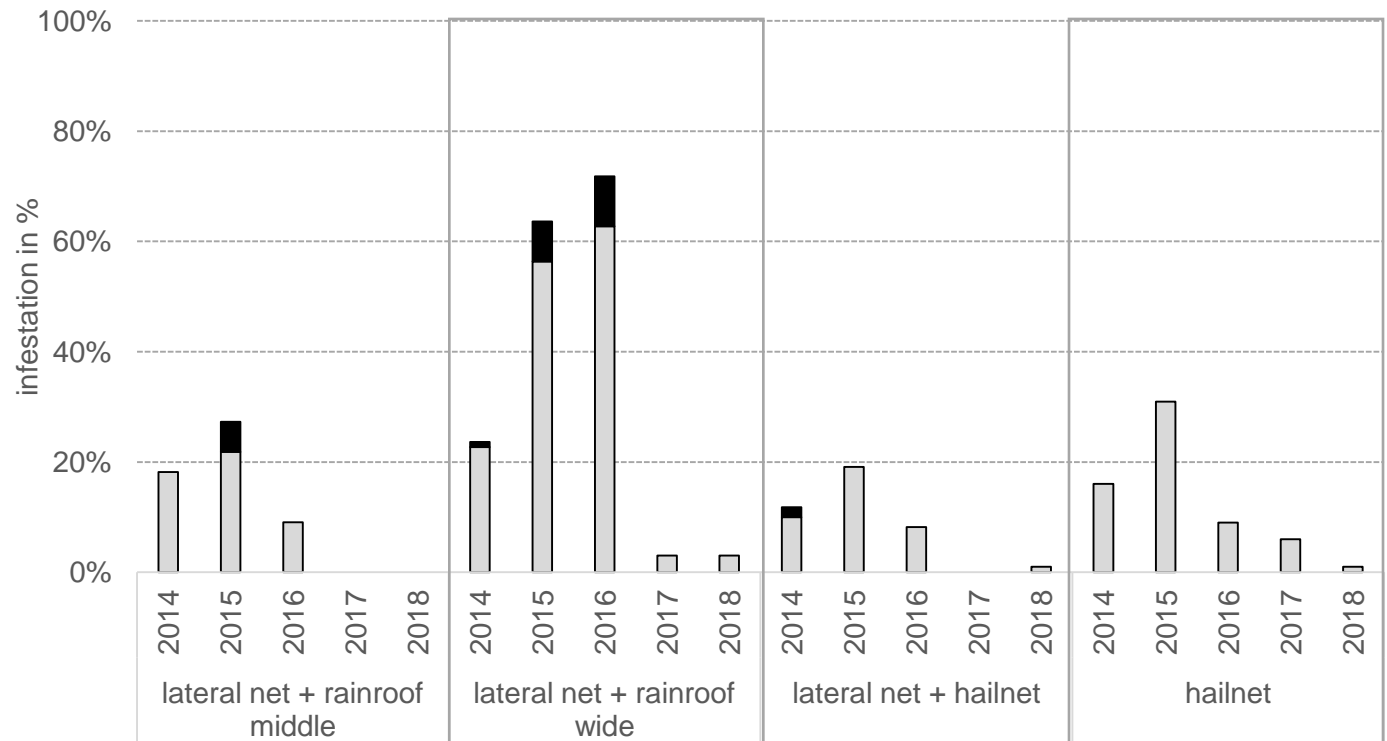
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# Effect of rain roof system on several pests

Eggs of spider mite - 100 observation spots per treatment

□ bis 10   ■ bis 50   ▒ bis 100   □ >100



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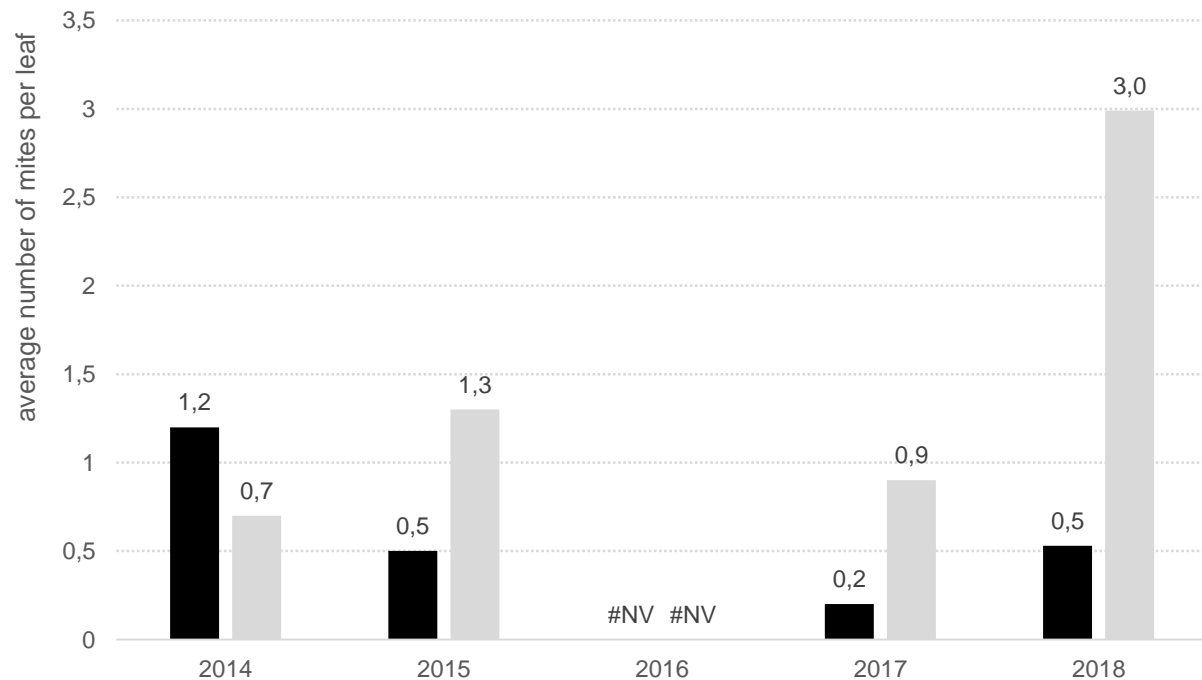
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# Effect of rain roof system on several pests

## Predatory mites – average number of mites per leaf

■ hailnet ■ lateral net + rainroof wide



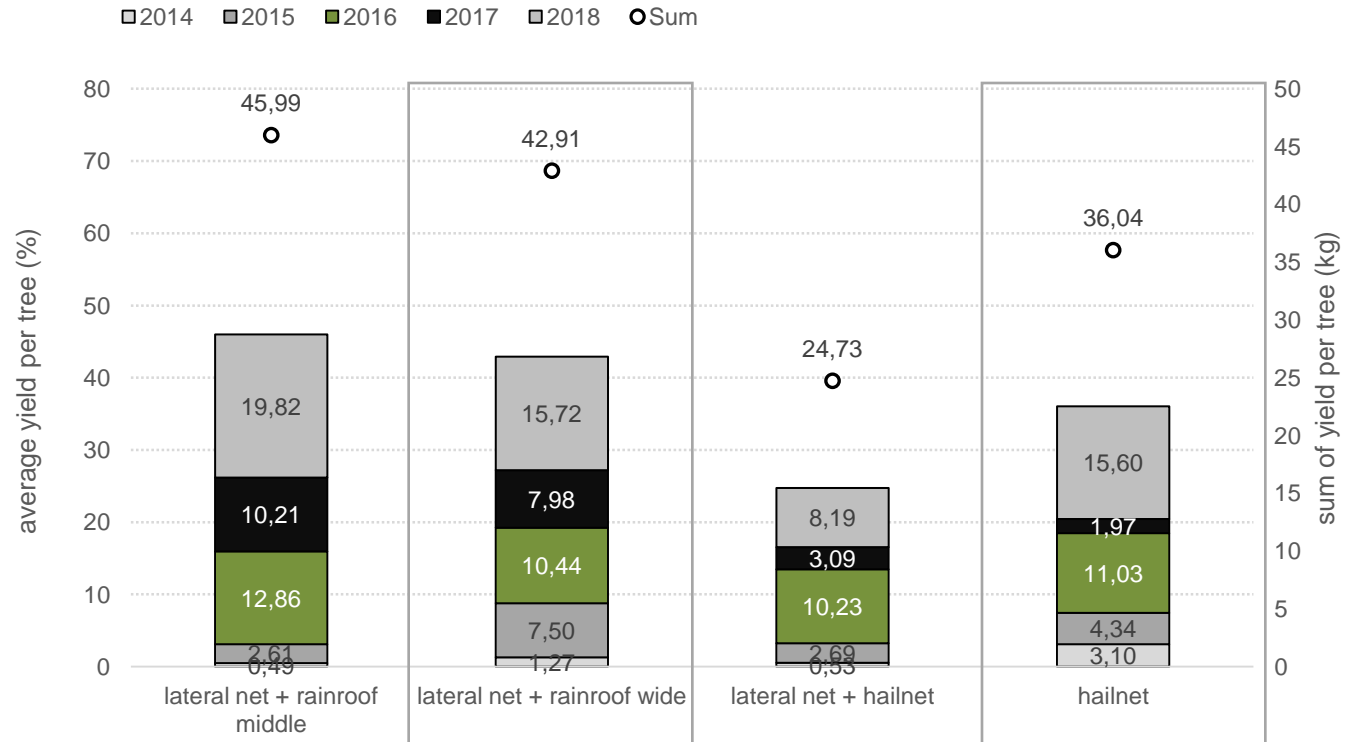
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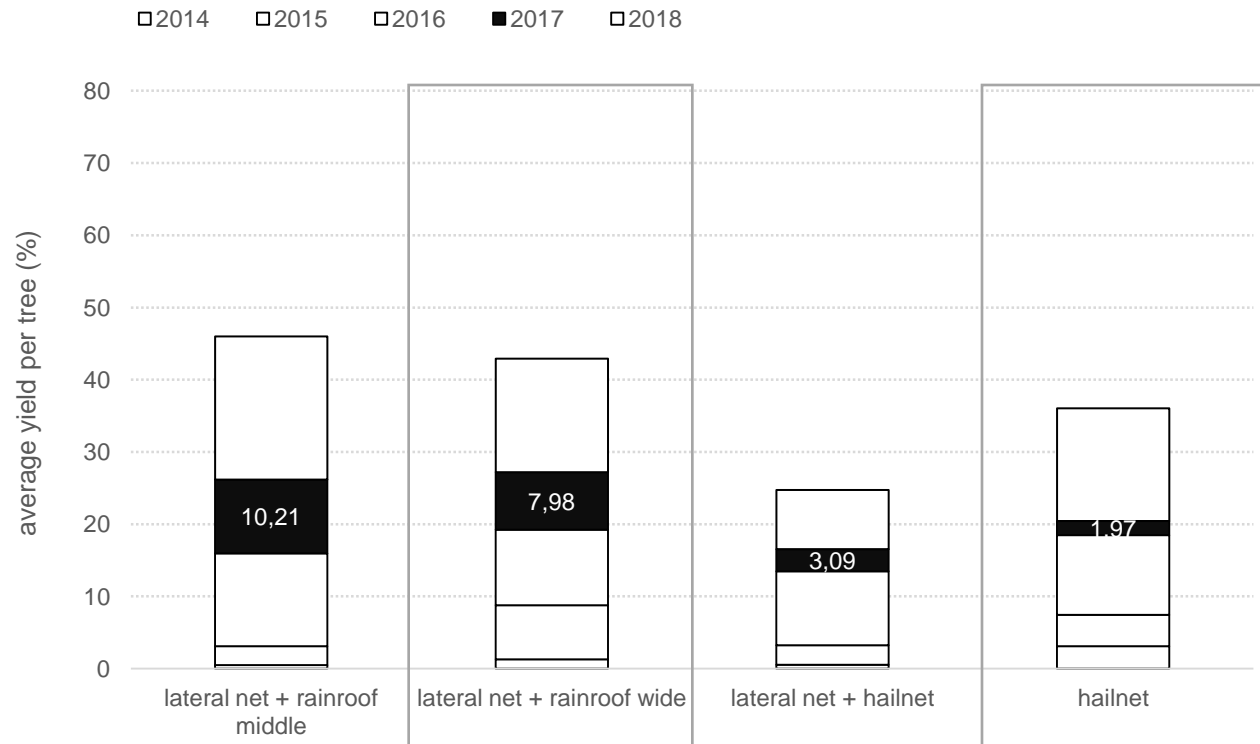
# Yield in the years 2014-2018

Accumulated yield per tree - 1., 2., 3., 4. and 5. year



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# Stability of plastic sheets

Stability of plastic sheet in the tested rain roof system

Year 3: 2016 - 154 cracks on 460 running meter



Yield



Stability



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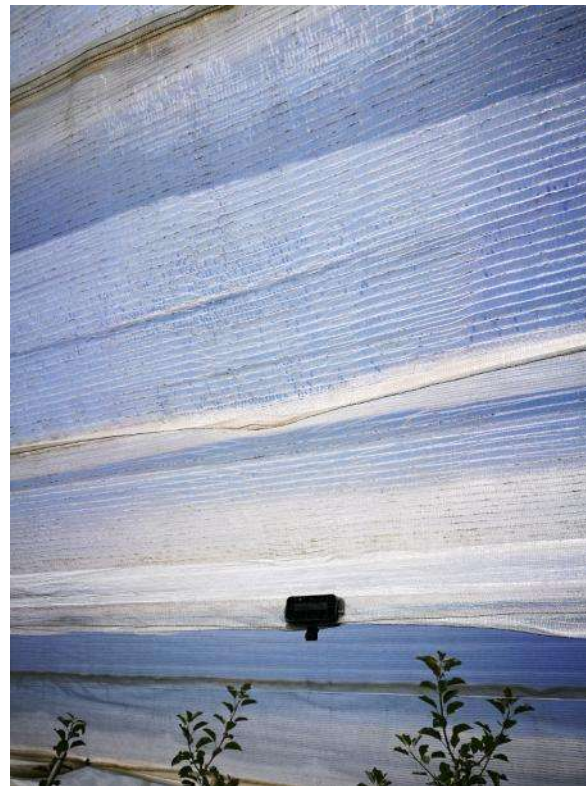
**Year 4: 2017** - Plastic dissolved and small plastic particles fall down



Yield



Stability



# Conclusions

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## Advantages of rain roof-system:

- Effective prevention of major diseases
- High potential for reduction of fungicide input
- Increasing amount of good quality - reduced losses caused by russeting, sunburn ...

## Disadvantages of rain roof-system:

- Higher costs
- Possibility of increasing problems esp. with sucking insects
- Disposal of waste (plastic sheet separate from hailnet)



# Conclusions

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## Further demand / open questions:

- Improvement of life period / stability of plastic sheets
- Development and test of non permanent roofing / retractable rain roof systems
- Evaluation of carbon footprint
- Performance of different apple varieties under roof (effect on growth, coloring)
- large-scale experience - long term development of diseases
- Landscape aspects

**interesting results, but not yet suitable for practice**