Deposit and coverage trials in orchard

Comparison of treatments with different droplet sizes and sprayers

Holland 2016

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Background and aim of the measurements

In the Netherland crop protection applications in orchards often are carried out with nozzles producing fine to very fine sprays.
In future application with fine droplets will be prohibited in the Netherlands and treatments must to be carried out with medium to large droplets.

With regard to equipment a huge variation is on the market and trends are going towards the use of multiple row sprayers instead of single row equipment in order to increase work rate.

The presented trials show results from application done with different types of air blast sprayers, a single row sprayer, a twin row sprayer and a triple row sprayer.
All the three sprayers were tested with standard hollow cone nozzle producing fine sprays and injector hollow cone nozzles producing medium size droplets, to prevent drift.

The aim of the activity is, to see if there are deposit and/or coverage differences between treatments with standard hollow cone and injector hollow cone nozzle and to verify if there are application quality differences when using multiple row sprayers compared to single row equipment

Results summary

In the Netherlands crop protection products often are appied withe fine to very fine droplets.
In order to reduce unwanted negative product impact to the environment (water chanals etc.) farmers will be obliged to change to medium to coarse droplet application from 2017 on.
Thus deposit and coverage trials on orchards in Holland were requestedt to carry out in order to verify the application quality from treatments with fine and coarse sprays.

Several treaments were done with standard hollow cone nozzles (fine spray) and injector hollow cone nozzles (coarse spray). Product deposits, product distribution across the trees and leaf coverage were measured

Additionally a test of three different sprayers was included.
A standard axial single row orchard sprayer, a twin row orchard sprayer and a triple row orchard sprayer.

The results achieved showed, that application with medium to large size droplets were similarly good to treatments with fine droplets.
Deposit on the targets (apple leaves) for the large droplet application were as good or even higher than for the application with finer droplets in all positions of the trees. With regard to leaf coverage treatments with fine droplets showed better results.

Nevertheless the injector nozzles tested are fit for the use in orchard spraying

From the three sprayers tested the triple row KWH sprayer showed best results. Deposits as well as coverage of the apple leaves were high. The cross-flow type of air system apparently here has some advantages over the other systems.
For the twin row sprayer deposits and leaf coverage were low for some leaf positions. One of the issues of this sprayer might be the non-uniform fan system and nozzle set up.
Trial data from Italy 2008 and Germany 2014 show very similar results and proove the findings of the trials in Holland 2016.

Sprayers, nozzles and application parameters

Lochmann single row sprayer

Nozzles and application parameters

Nozzles	ATR	TVI
Nozzle type	standard hollow cone	hollow cone injector
Nozzle size	lilac/brown	8001
Pressure	7 bar	7.5 bar
Speed	7.2 km/h	7.8 km/h
Spray volume	220 l/ha	220 l/ha
Spray quality	fine	coarse

Sprayers, nozzles and application parameters

Wanner twin row sprayer

Fan system on one side only (middle) and a baffle plate on the outsides to guide the arriving air from the fan system back to the crop row

In the centre 9 nozzles are mounted and on the baffle plates are 5 nozzles only

Nozzles and application parameters

ATR	Nozzles	TVI
standard hollow cone	Nozzle type	hollow cone injector
lilac	Nozzle size	80 01
7 bar	Pressure	7 bar
7 km/h	Speed	7 kn/h
170 l/ha	Spray volume	220 l/ha
fine	Spray quality	coarse

Sprayers, nozzles and application parameters

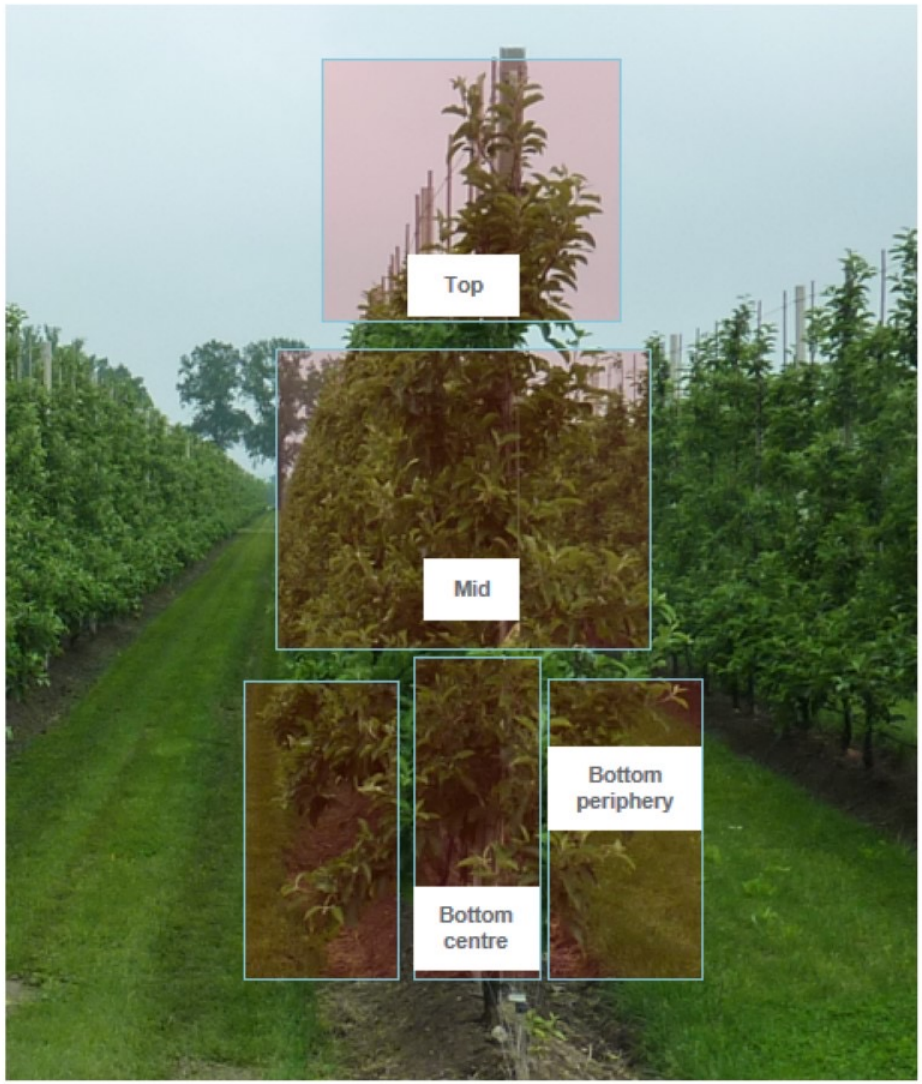
Nozzles	ATR	TVI
Nozzle type	standard hollow cone	hollow cone injector
Nozzle size	lilac	80 0075
Pressure	7.5 bar	7.5 bar
Speed	7.5 km/h	7.5 km/h
Spray volume	200 l/ha	200 l/ha
Spray quality	fine	coarse

Sprayers, flow rate calibration

To ensure correct spray volume nozzle flow rates were calibrated prior to the applications.

Application speed was measured during the application in the field.

Crop parameters and sampling positions on the trees



Crop parameters

Foliage height:	2.7 m
Foliage width:	1.1 m
Row distance:	3.25 m
Planting distance:	1.0 m
Number of trees/ha:	3'077
Crop volume:	9'200 m^3
Leaf Area Index:	1.8 (18'000 m^2 of leaves area /ha)

Leaf sampling

For deposit and coverage measurements leaf samples were taken at different sections of the tree
For each sampling level 12 samples of 20 leaves were taken for deposit analysing and 50 leaves were taken for coverage measurement

Sampling levels

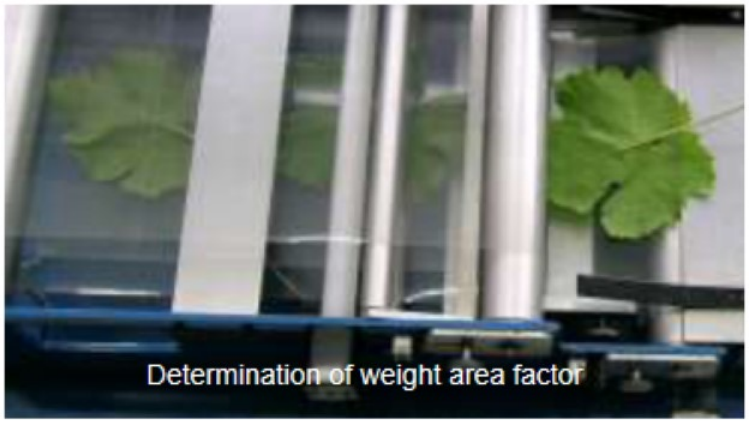
top, mid, bottom periphery, bottom centre

For the treatments with the Wanner sprayer samples were taken from both sides of the trees separately in order to check product distribution uniformity of the system (fan system on one side only, baffle plates on the outer side, non-uniform set up regarding nozzles (9 + 5)

For all other treatments samples were taken across the whole sampling level

Sample preparation and analytical process for deposit measurement...

To enable deposit and coverage measurements an optical brightener, Helios SC 500, was added to the spray solution at a concentration of 0.1 %
This product has no impact on the physical properties if the spray is non-toxic nor phytotoxic


Determination of weight area factor


Weighing of samples, determination of sample area

Measure fluorescent concentration in washing solution


Filtering washing solution


Wash off tracer from collector

Steps for deposit determination:

Leaf area determination by weighing each sample
Washing off the tracer form collectors with an organic solvent
Filtering the washing solution and concentration measurement with a Fotofluorometer
Calculation of deposit

Leaf coverage measurements

For coverage measurements fotos from both sides of the leaves were taken under UV light.
Coverage calculation was done by the optical program Fluorsoft

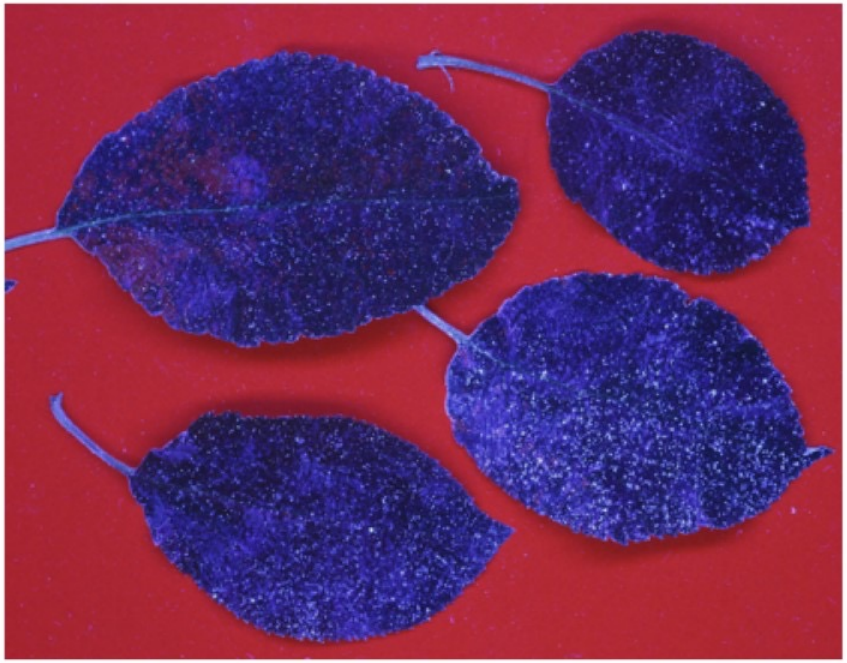
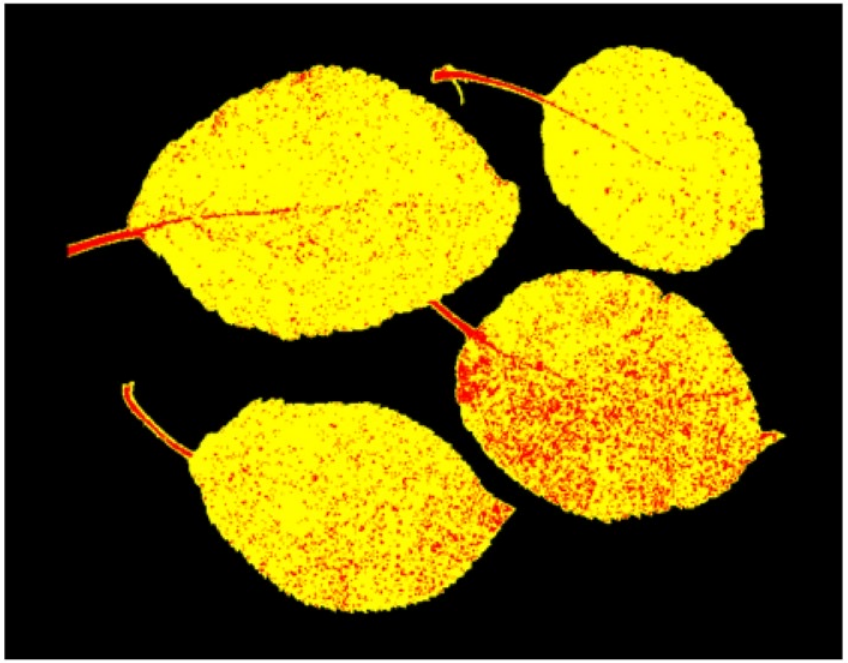


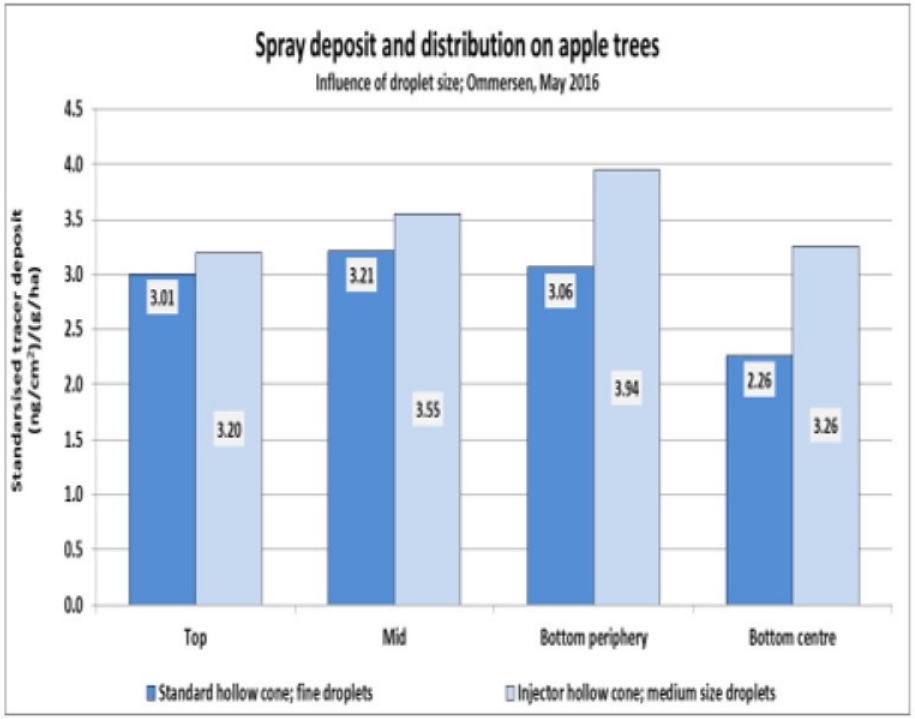
Foto of the leaves taken under UV light

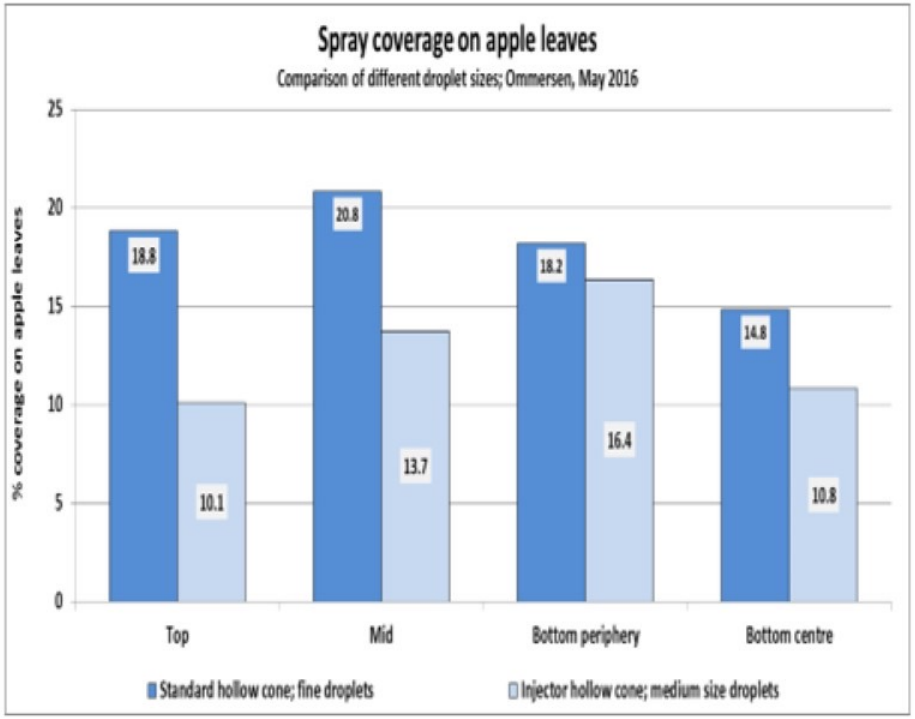


Coverage converted by the program for the calculation of the covered area by the UV tracer

Results; product deposit and leaf coverage fine/medium size droplets

Average of all sampling levels and sprayers





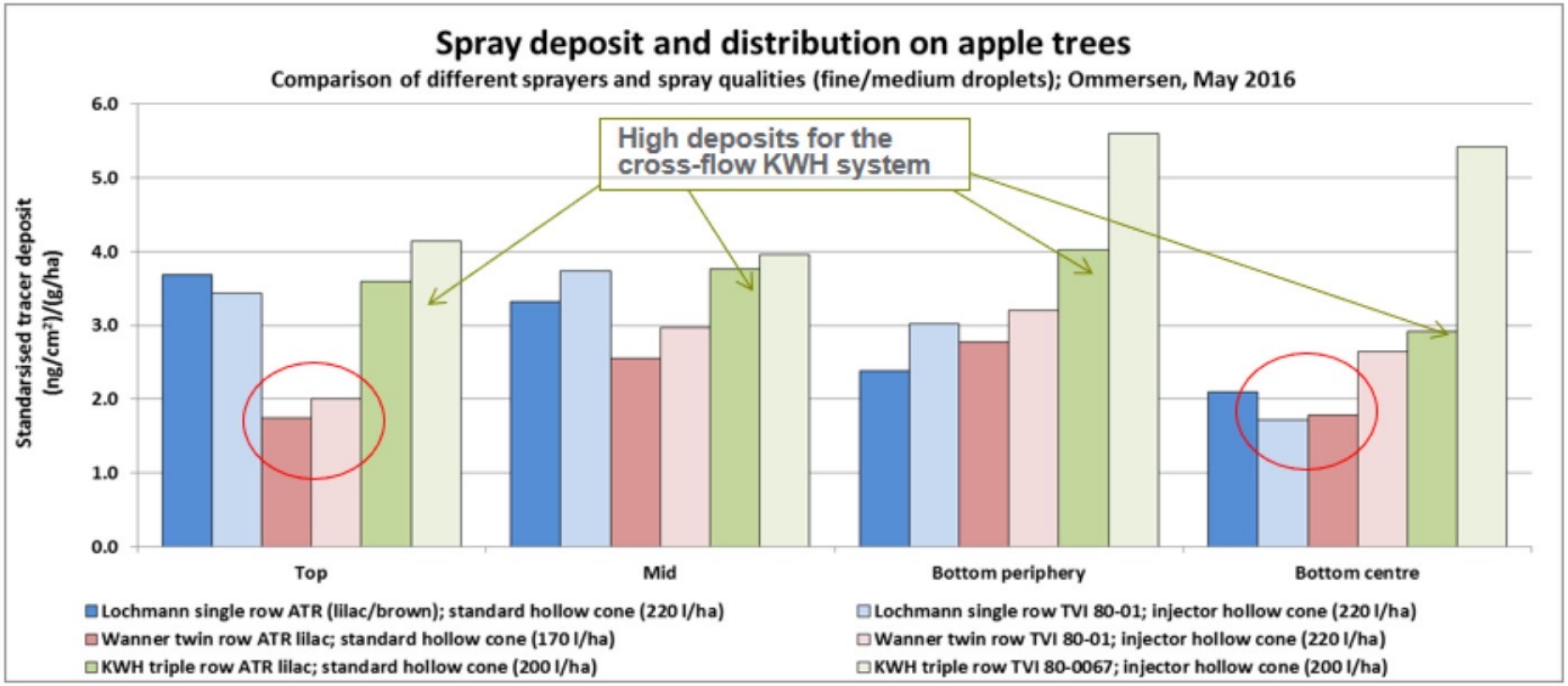
Average of all treatments

- Product deposition for the two spray qualities (fine and medium droplets) were similar on top an mid levels of the trees. On bottom leaves product deposits from application with larger droplets were higher.
- Deposit distribution across the trees (leaf wall) was very uniform for fine and medium size droplets
- No disadvantage of the larger droplets regarding product deposition on the targets

- Leaf coverage for the fine droplet applications was higher than for medium droplet applications
- Finer droplet application results in slightly more uniform leaf coverage across the trees
- Regarding leaf coverage a slight disadvantage for the medium droplet size applications were seen

Results; product deposit and leaf coverage fine/medium size droplets

Sprayers and sampling levels

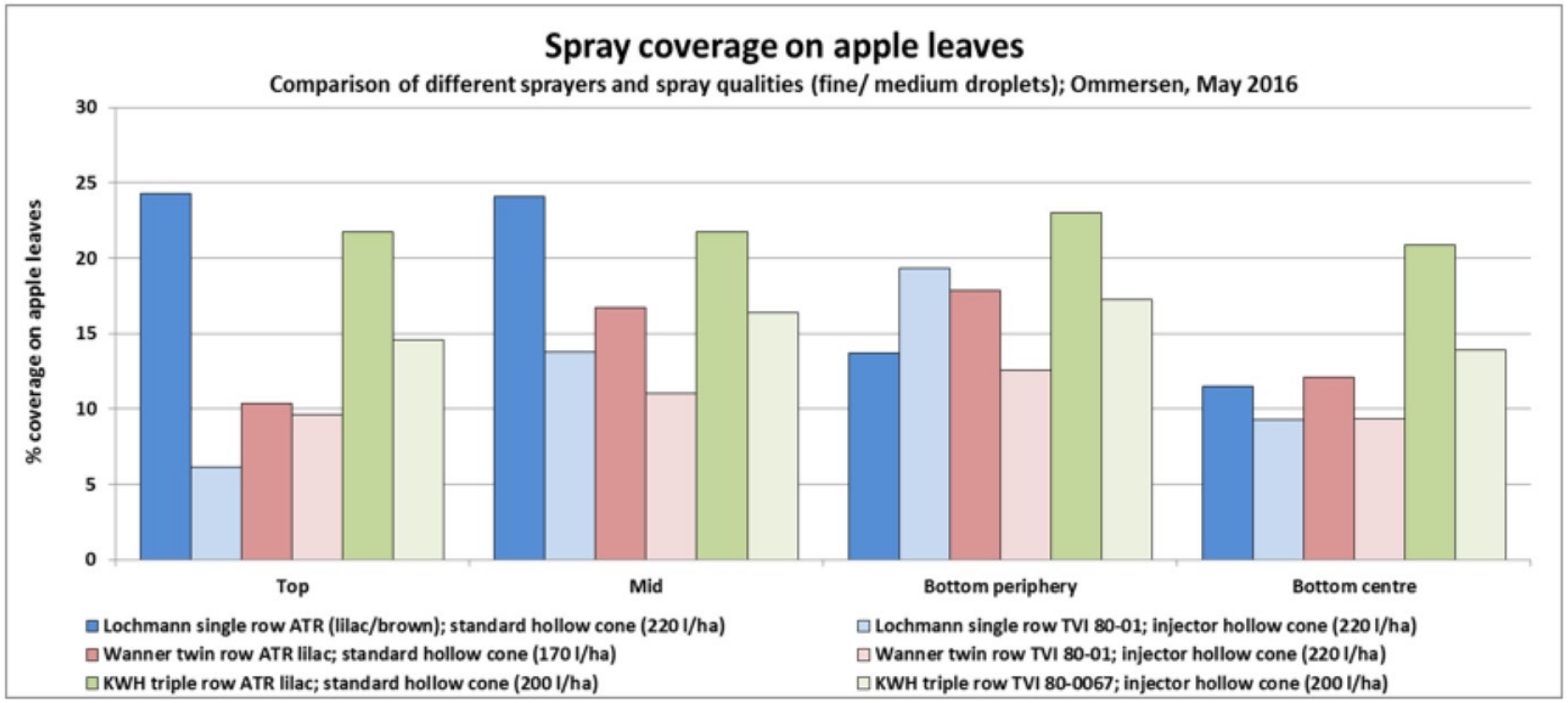


Sampling levels and sprayers

- For all sampling levels and sprayers product deposits from the treatments with medium size droplets (induction nozzles) were equal or higher than for the treatments with fine droplets (standard ATR hollow cone nozzles
- High deposits on all leaf levels were found for the KWH triple row sprayer. The geometry of the cross-flow system shows its advantage
- Lowest deposits on most leaf levels were found for the Wanner twin row sprayer. The non-uniform air flow and nozzle setting (only baffle plate but no fan system for the outer part of the trees) may be a disadvantage with regard to spray guidance and distribution.

Results; product deposit and leaf coverage fine/medium size droplets

Sprayers and sampling levels



Sampling levels and sprayers

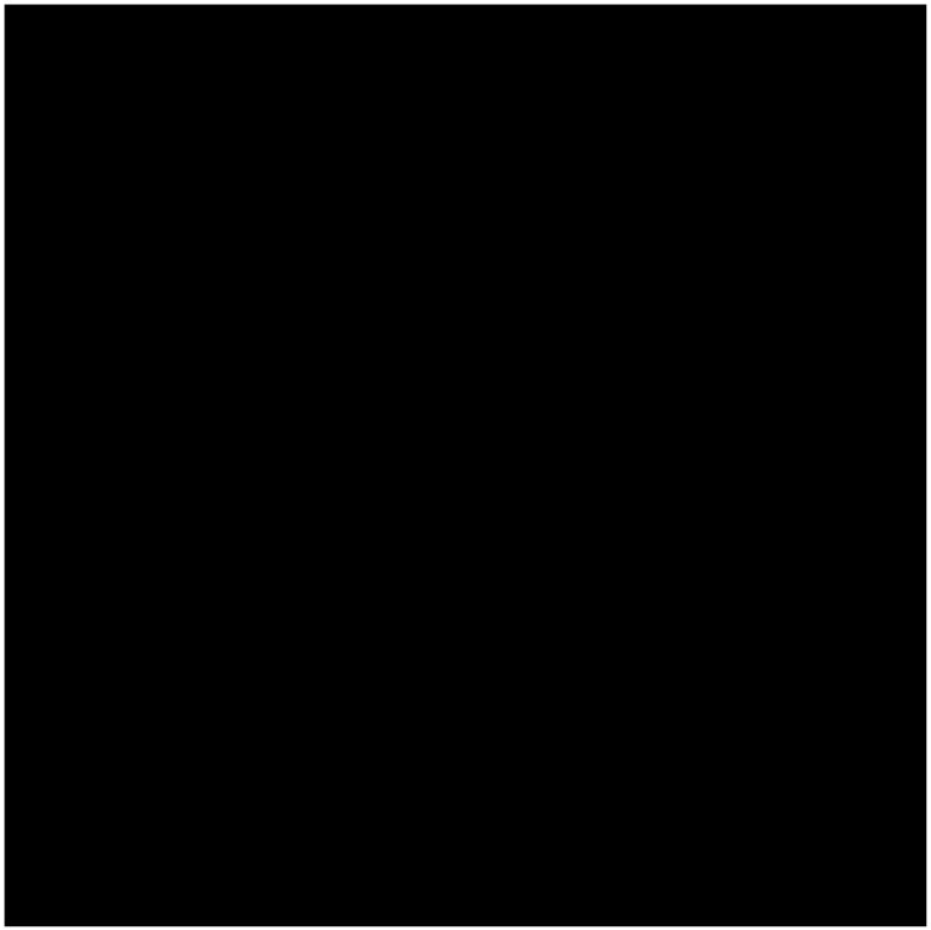
- Leaf coverage on all sampling levels and for all sprayers were higher for the fine droplet applications than for the treatments with medium size droplets. However the fine droplets produced by the standard hollow cone nozzles are prone to drift. The higher number of small droplets produced for similar or the same volume lead to higher leaf coverage.

Despite the higher coverage produced with fine droplet application, the lower deposit generated by these sprays (see graph above) show that many of the these small droplets do not reach the target 8drift away or sediment in the driveway between the crop row.
The often mentioned unfavourable droplet trajectory of the larger droplets providing low deposits were not seen

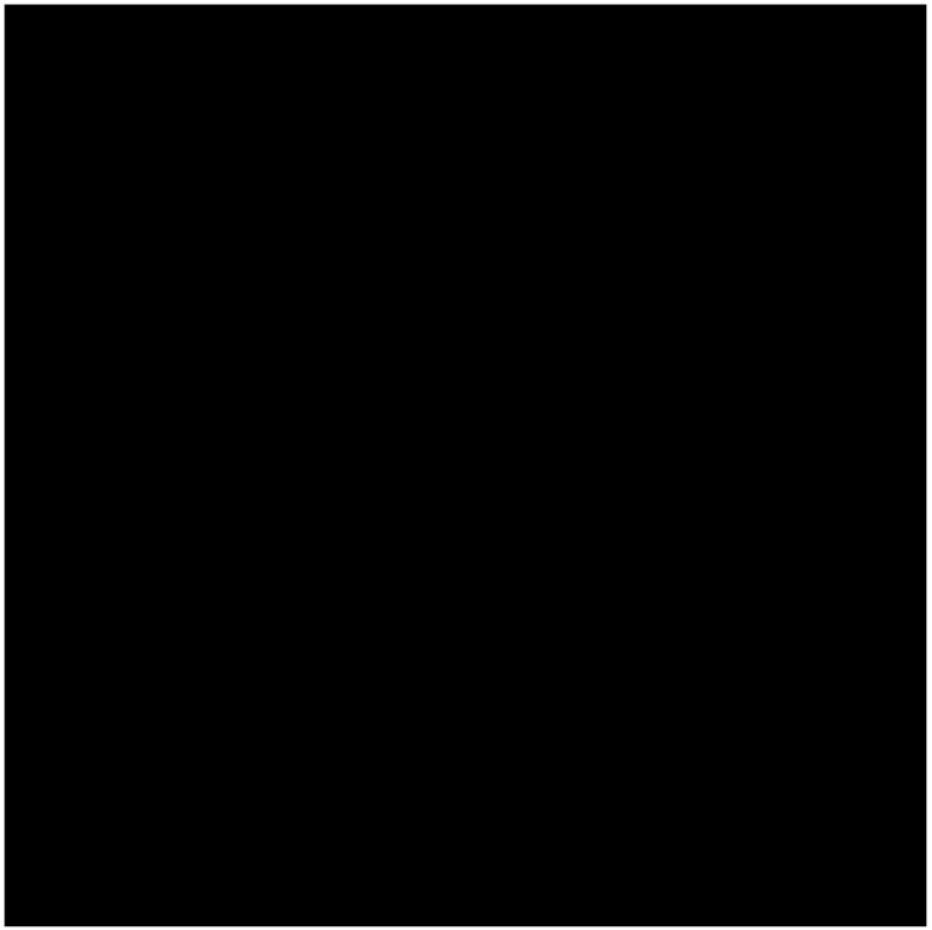
Application video

KWH Triple Row

ATR Lilac

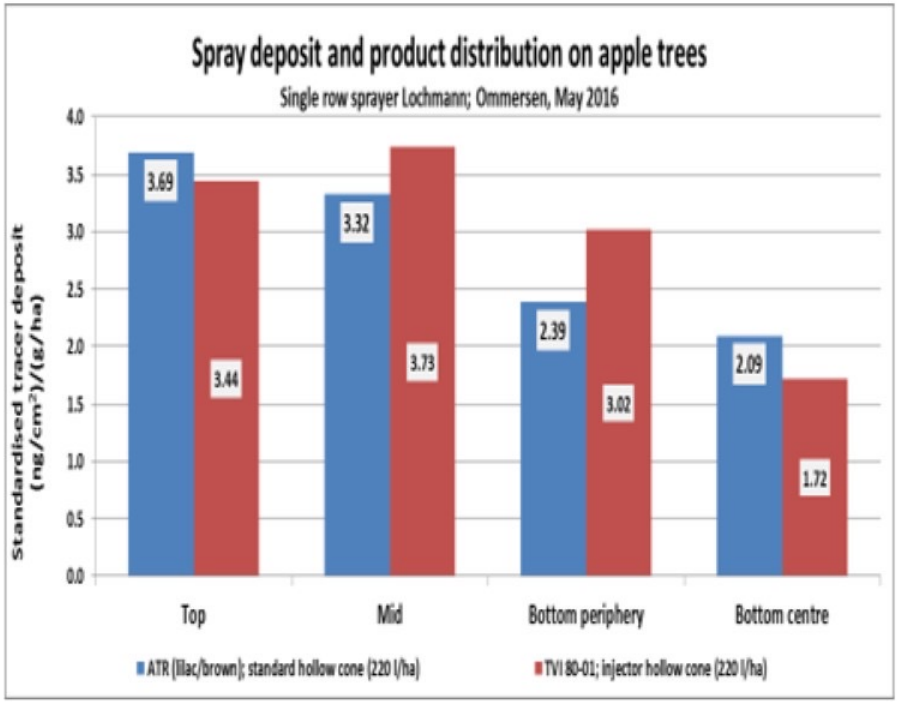


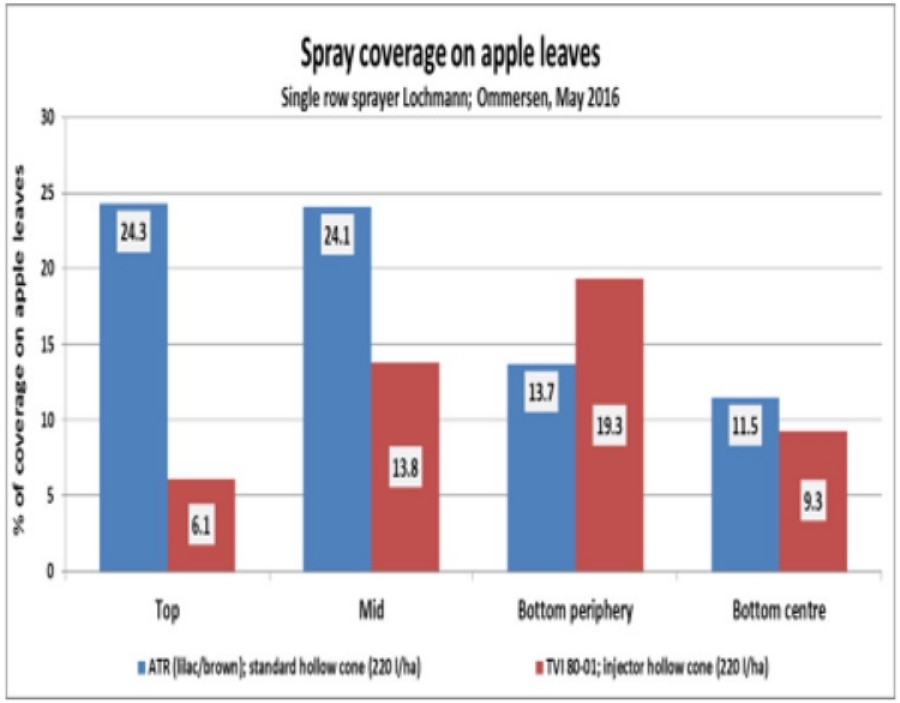
TVI 800075



Product deposit, distribution and coverage

Single row sprayer Lochmann



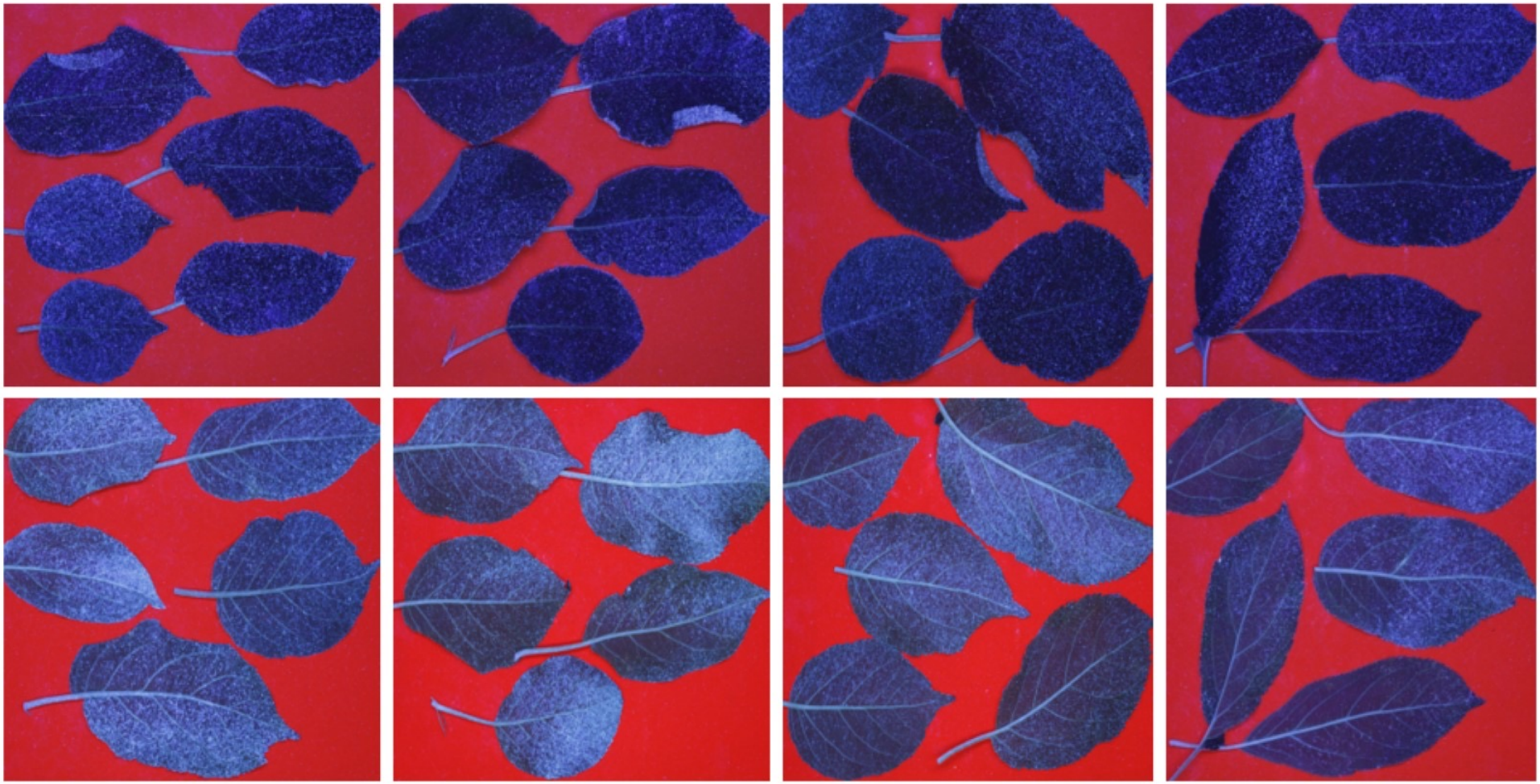


Deposit differences between fine and medium size droplet application are marginal

Huge difference in coverage, although deposits were very similar

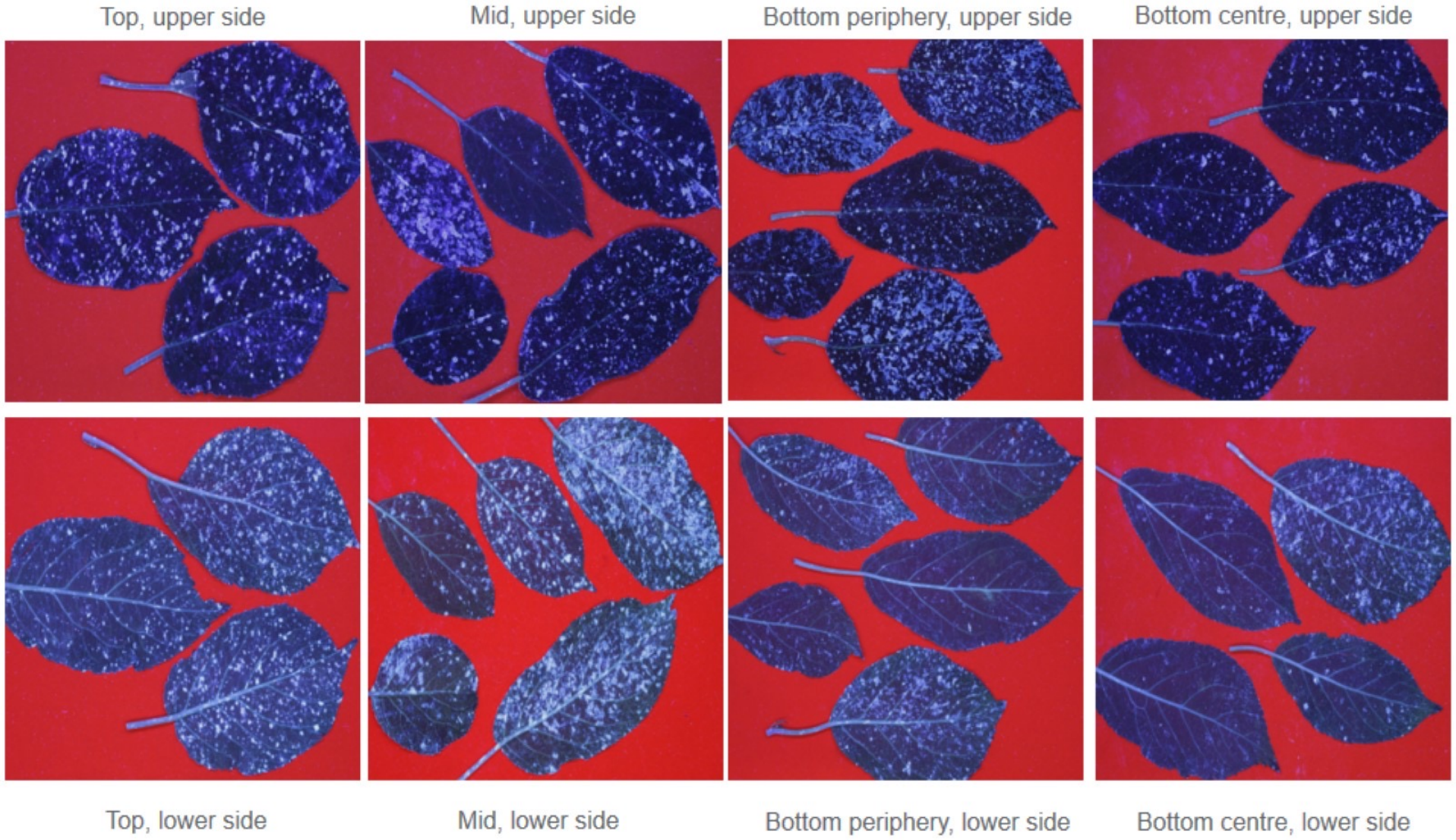
Leaf coverage

Single row sprayer Lochmann; ATR application, fine droplets



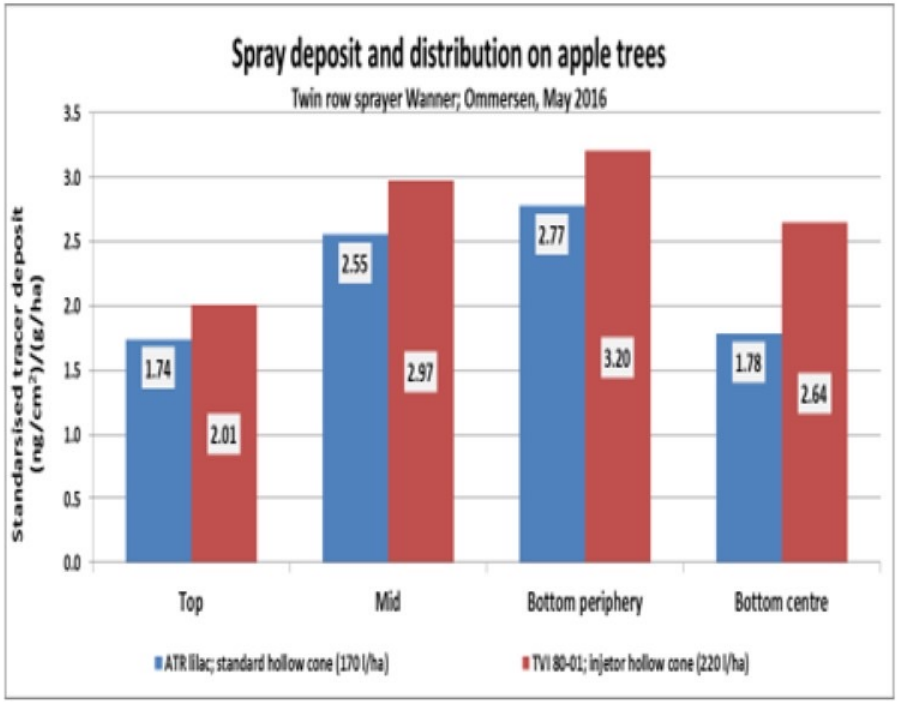
Leaf coverage

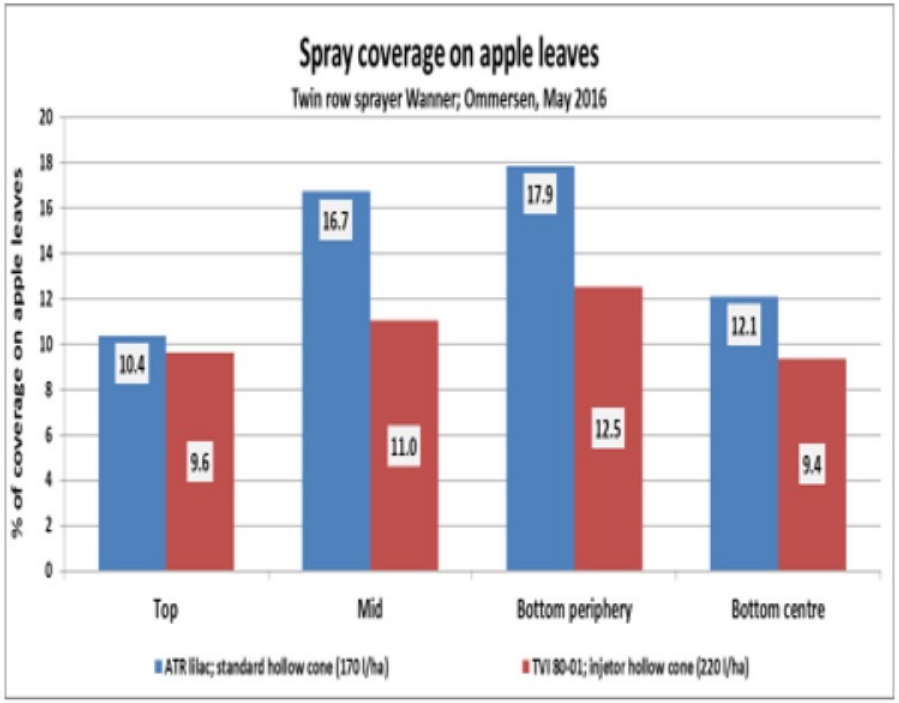
Single row sprayer Lochmann; TVI application, coarse droplets



Product deposit, distribution and coverage

Twin row sprayer Wanner





For all leaf levels deposits from medium droplet application were higher

Leaf coverage for the fine droplet application were higher on all leaf levels

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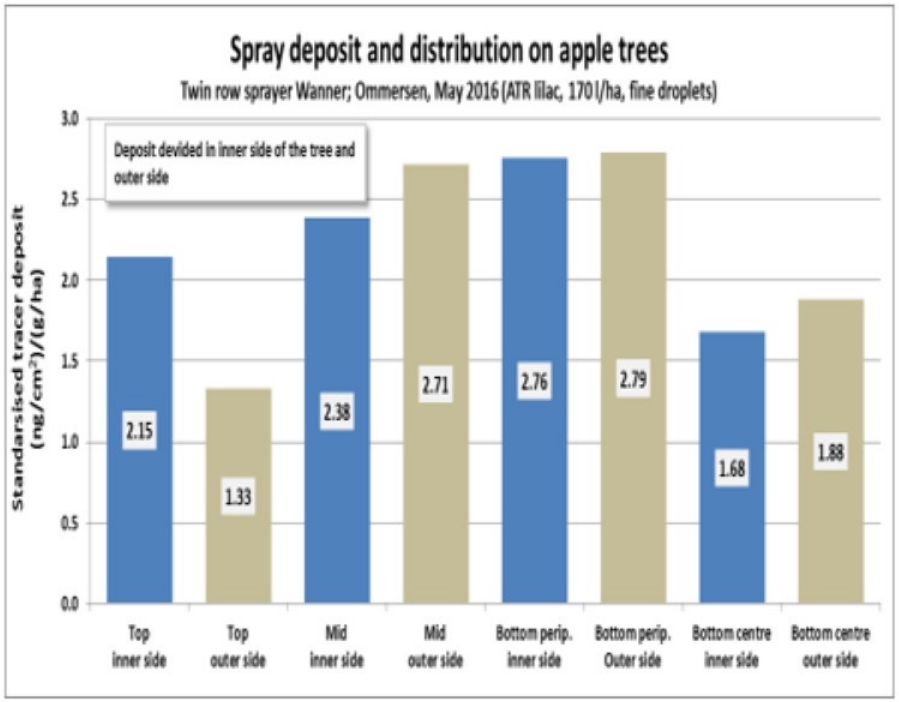
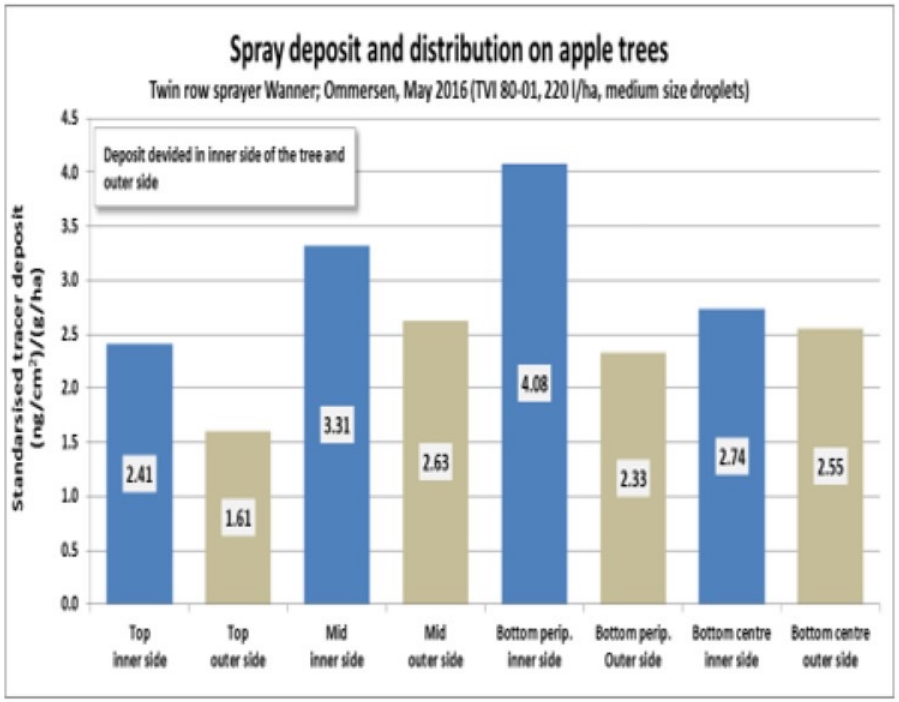
Product deposit, distribution and coverage

Twin row sprayer Wanner

Due to the fact, that this twin row sprayer only blows air from the centre of the equipment to the outside, and from the outside the air is guided back to the crop row by a baffle plate, (see slide 6) it was interesting to see if product distribution across the whole tree was uniform



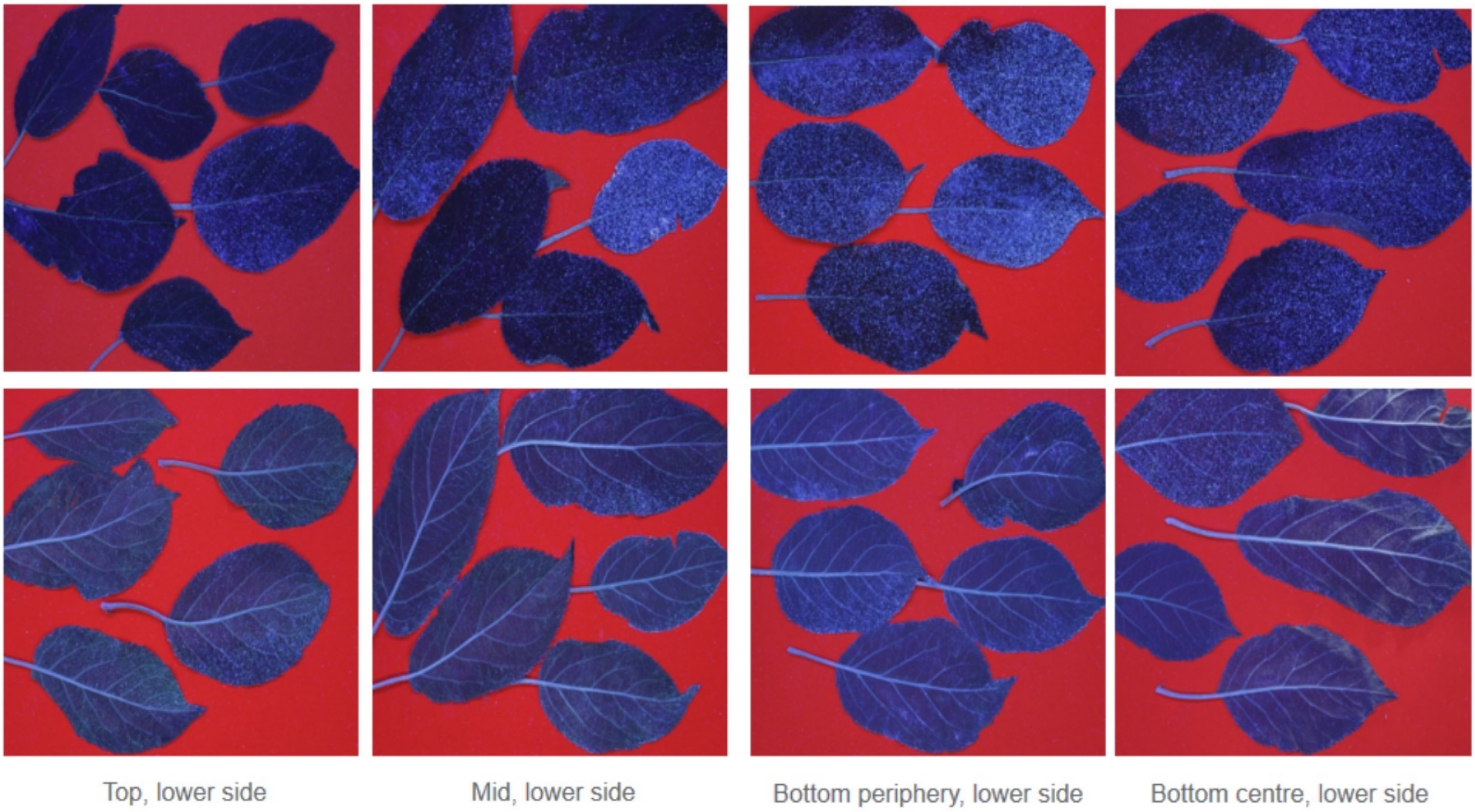


Deposit differences between the two tree sides were seen for the treatments with larger droplets (inner side, where the fan system is blowing the air directly to, and outer side, where the air is guided by the baffle plate). For the application with fine droplets almost no differences were seen.

This shows, that the flow of the air that is guided back towards the trees by the baffle plates is strong enough to carry fine and very fine droplets, but for slightly heavier droplets (medium size and larger) it seems to be too weak.

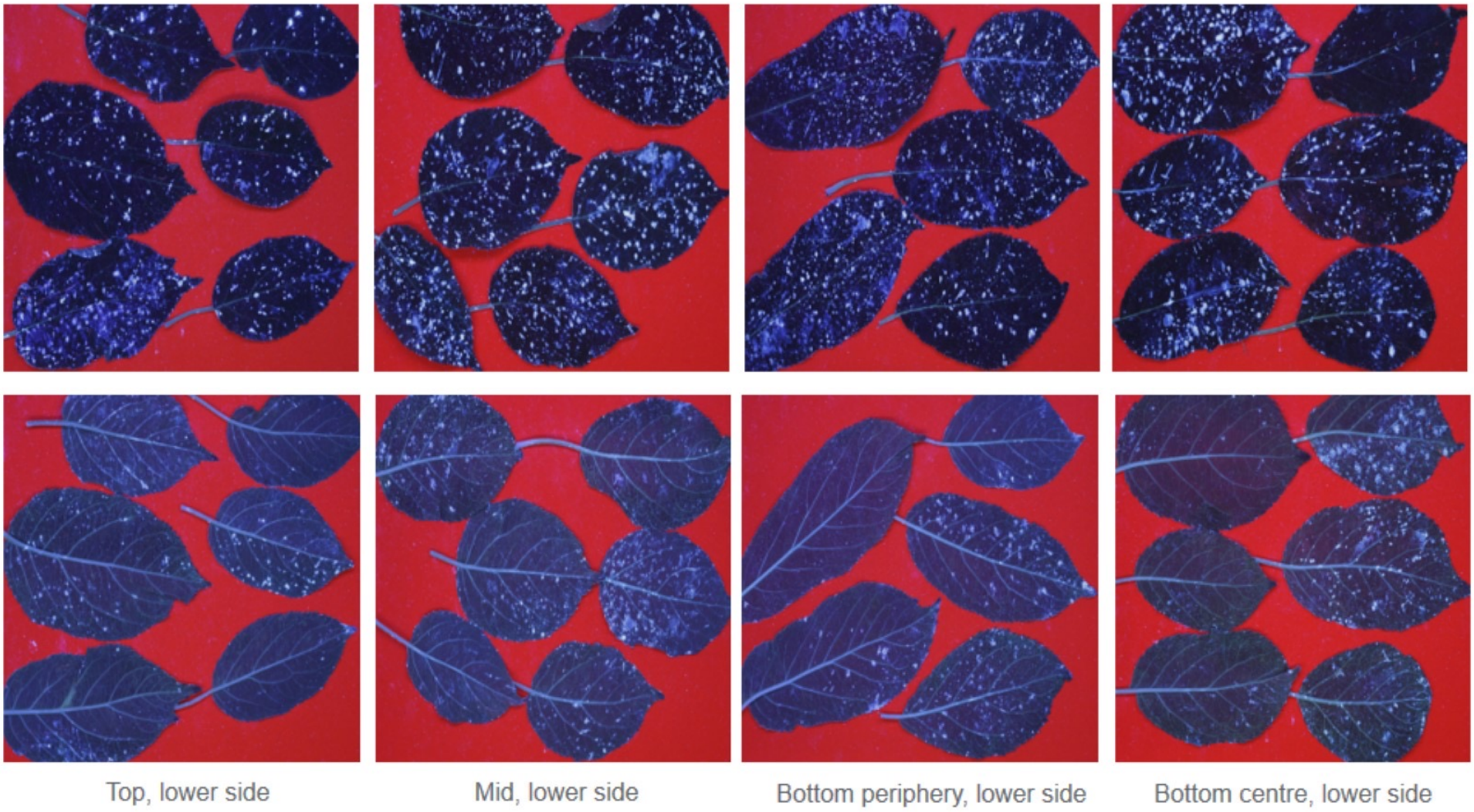
Product coverage

Twin row sprayer Wanner, ATR application, fine droplets



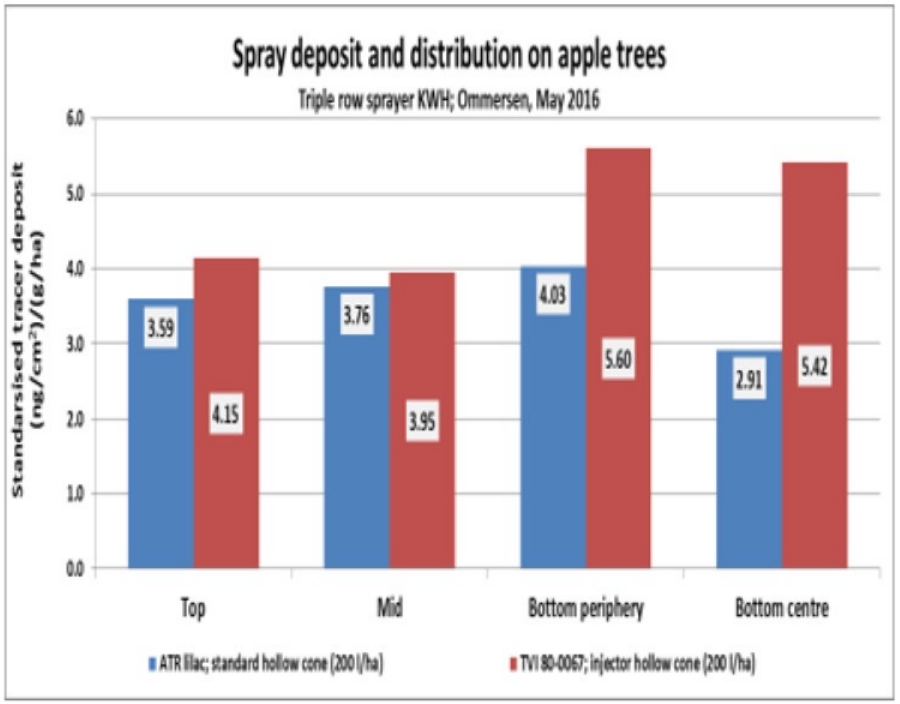
Product coverage

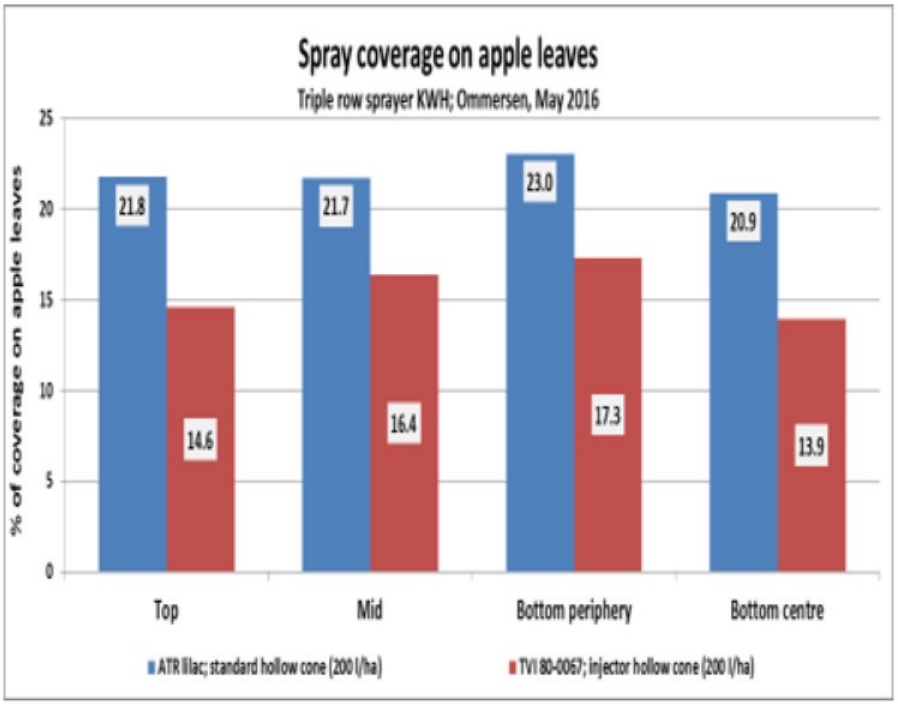
Twin row sprayer Wanner, TVI application, coarse droplets



Product deposit, distribution and coverage

Triple row sprayer KWH





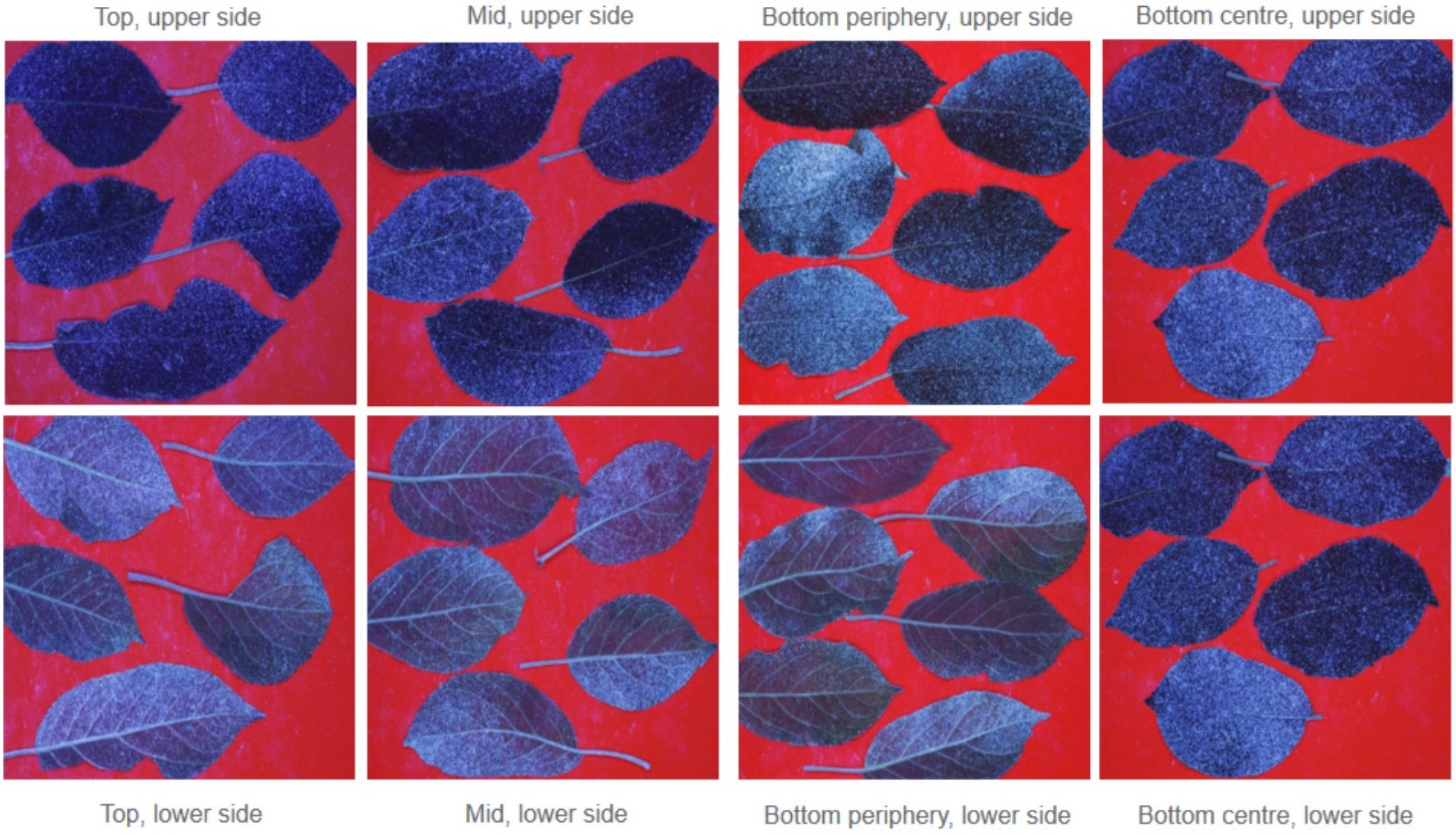
Similar picture for the KWH triple row sprayer than for the two previous equipment

Equal product deposit or higher for the treatment with larger droplets, but lower coverage than for the application with fine droplets

Uniformity of the deposit and mainly of the coverage is much higher than for the treatments with the single and the twin row sprayer. An advantage of the cross-flow type of fan system

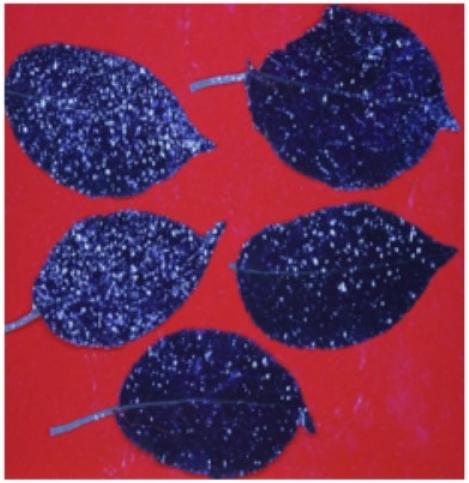
Product coverage

Triple row sprayer KWH, ATR application, fine droplets



Product coverage

Triple row sprayer KWH, TVI application, coarse droplets

Top, upper side	Mid, upper side	Bottom periphery, upper side	Bottom centre, upper side
			
			
Top, lower side	Mid, lower side	Bottom periphery, lower side	Bottom centre, lower side

Italy; San Michele 2008

Nozzles and parameters

	Standard nozzle	Anti drift nozzle 1	Anti drift nozzle 2
Nozzle	Albut ATR hollow cone nozzle	Lechler ID 90-02 air induction flat fan nozzle	Albuz AVI 8002 air induction flat fan nozzle
			
Recommended pressure range	3 – 25 bar	3 – 20 bar	3 – 7 bar
Spray angle	80 °	90 °	80 °
Droplet spectra	fine to very fine	coarse to very coarse	coarse to very coarse
Drift potential	high	very low, rated as 50 % drift reduction by BBA	very low

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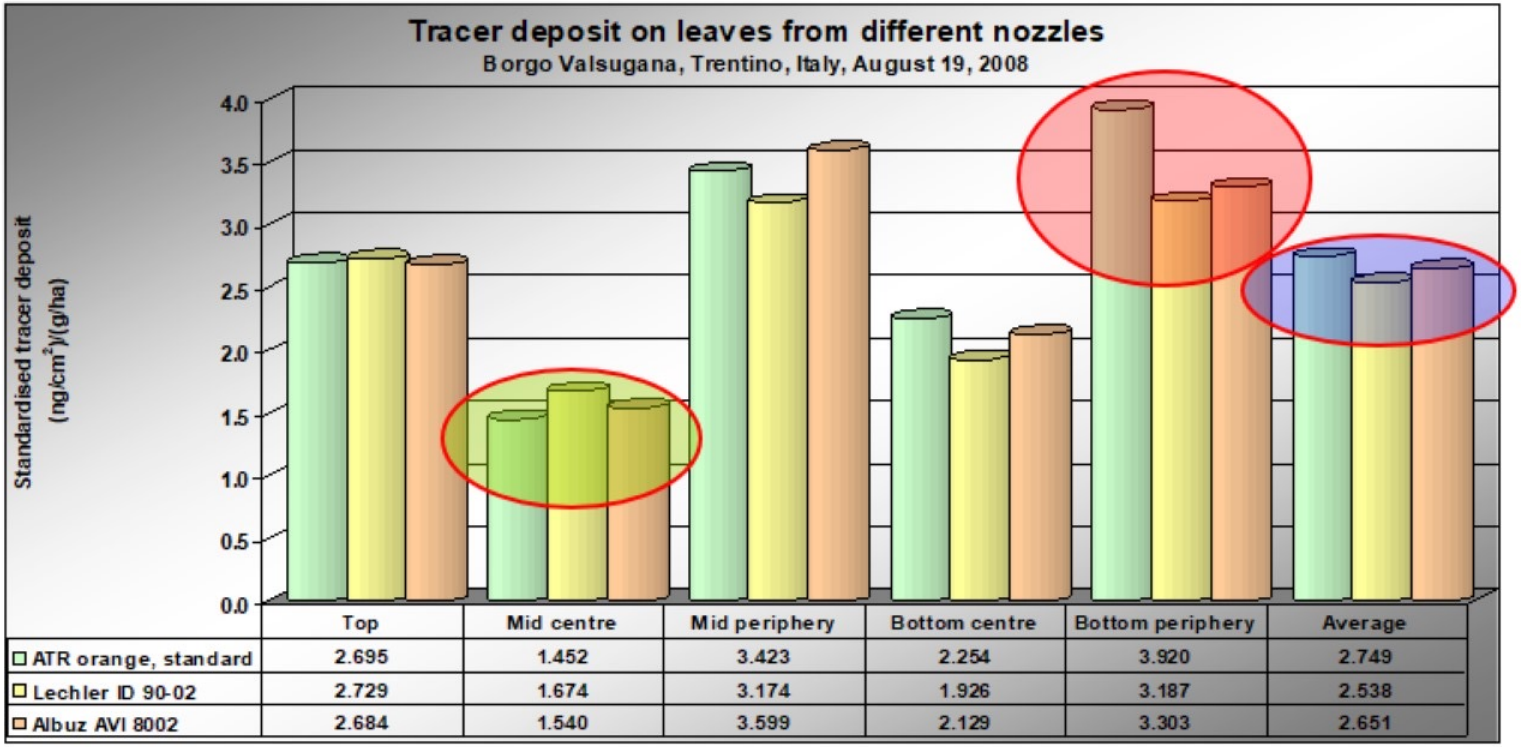
Italy; San Michele 2008

Product deposit



	Top	Mid centre	Mid periphery	Bottom centre	Bottom periphery	Average
ATR orange, standard	2.695	1.452	3.423	2.254	3.920	2.749
Lechler ID 90-02	2.729	1.674	3.174	1.926	3.187	2.538
Albuz AVI 8002	2.684	1.540	3.599	2.129	3.303	2.651

- Average deposits on leaves were very similar for all treatments. Although they were a little low for the calculated leaf area index, they were within an acceptable range
- Product distribution was the same for all treatments, showing higher deposits on the periphery of the leaf wall than inside the tree
- A slight advantage in product deposit was seen for the anti drift nozzles in position mid centre, whereas for the standard treatment deposits were slightly higher than for the anti drift nozzles on the bottom of the crop (trajectory and volume of each single droplet)

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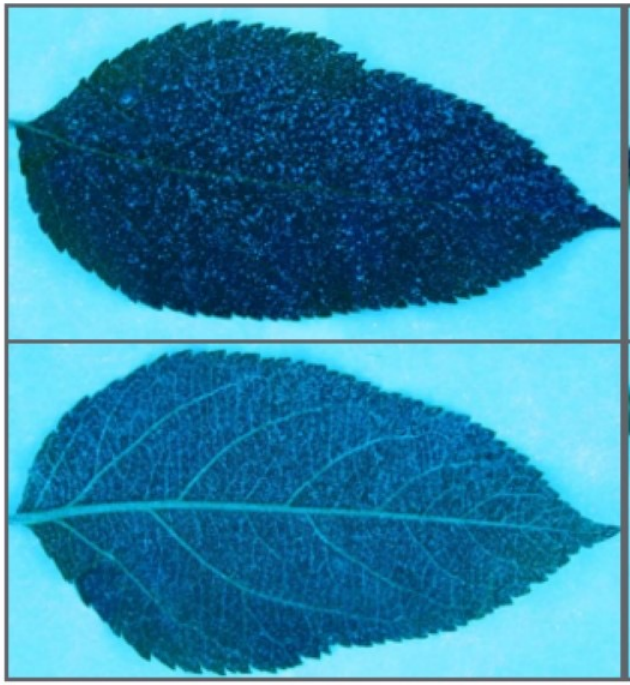
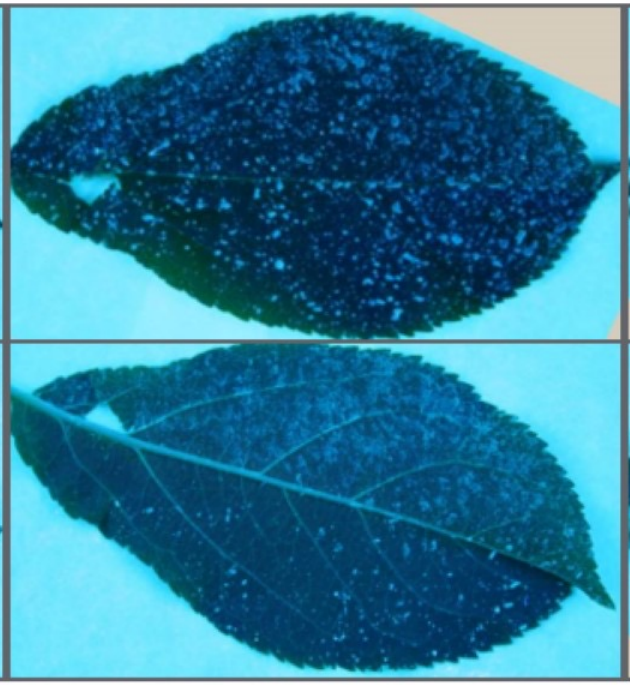
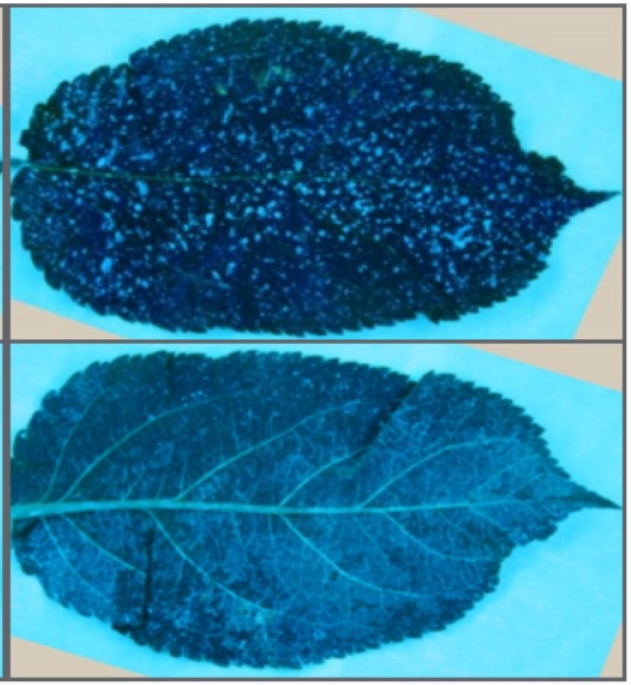
Italy; San Michele 2008

Leaf coverage

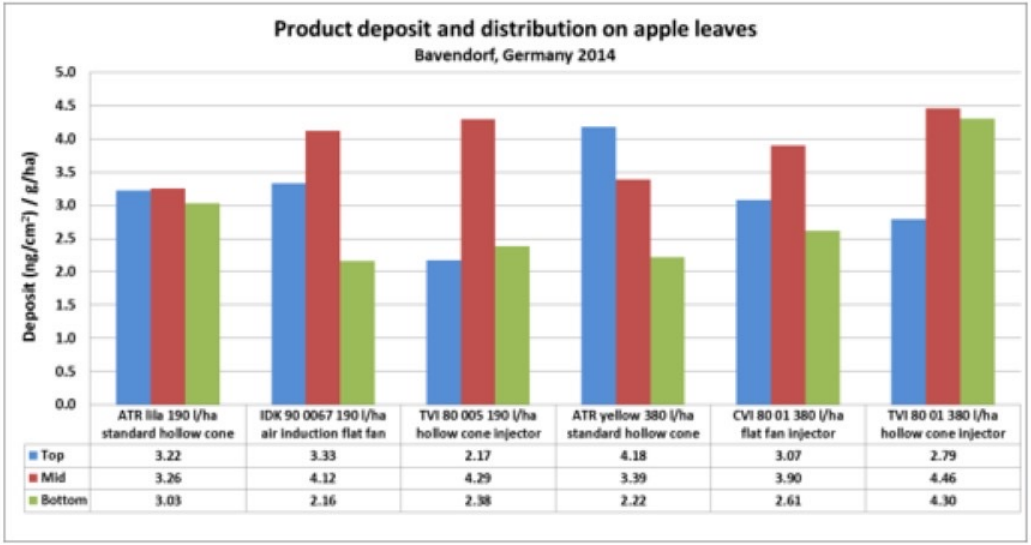
Leaf coverage was measured with a program which still is under construction, but it still can show trends regarding coverage and coverage differenced form the used nozzles

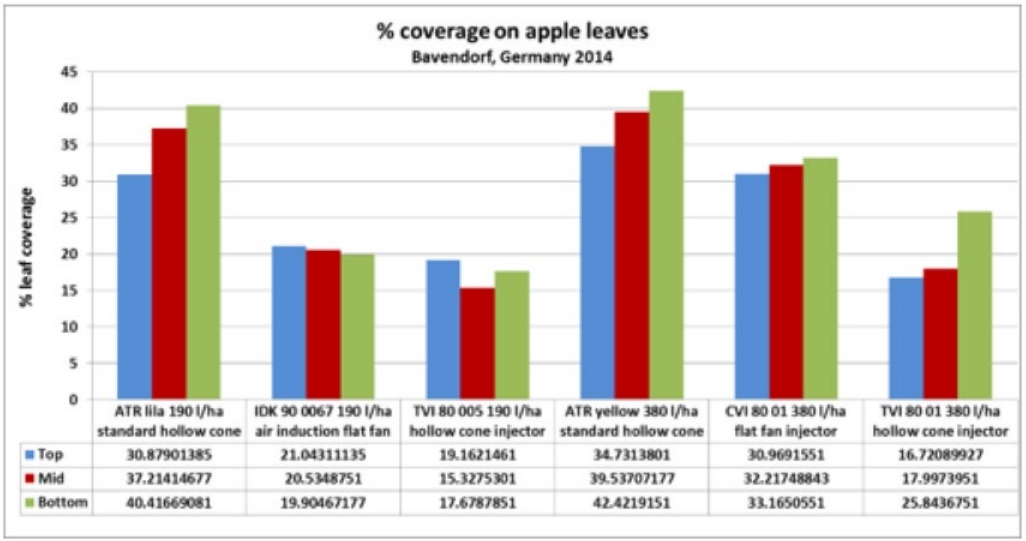
Albuz ATR orange, hollow cone Standard nozzle	Lechler ID 90-02 Air injector flat fan nozzle	Albuz AVI 8002 Air injector flat fan nozzle
		
Leaf coverage Upper leaf side: 17 % Lower leaf side: 46 %	Leaf coverage Upper leaf side: 20 % Lower leaf side: 35 %	Leaf coverage Upper leaf side: 22 % Lower leaf side: 42 %

Pictures are examples only. Coverage was with ~20 % on the upper side of the leaf and ~40 % on the lower leaf side very similar for all treatments. Visually coverage look greater than what was measured

Germany 2014

Fine droplets vs coarse droplets





- Medium to coarse droplet application equaly good than fine droplet application, althoigh coverage can be slightly reduced No decrease of amount of product deposed on the target)
- Larger droplets aer less prone to drift
- When using injector nozzles work at slightly higher pressure

Biologie; Blatt- und Fruchtschorf; 190 l/ha Applikationen				
Sorte	Düsentyp	Blattschorf 04.06.2014	Blattschorf 25.07.2014	Fruchtschorf 04.08.2014
Gala	ATR lila	0.3%	0.0%	0.2%
	IDK 90-0067	0.1%	0.4%	0.2%
	TVI 80-0075	0.4%	0.4%	0.5%
Elstar	ATR lila	1.0%	0.6%	0.1%
	IDK 90-0067	1.2%	1.0%	0.0%
	TVI 80-0075	0.2%	0.7%	0.0%
Jonagold	ATR lila	0.2%	0.6%	0.0%
	IDK 90-0067	0.3%	0.4%	0.0%
	TVI 80-0075	0.2%	1.0%	0.0%
Kanzi	ATR lila	0.0%	0.0%	0.0%
	IDK 90-0067	0.0%	0.0%	0.0%
	TVI 80-0075	0.0%	0.0%	0.0%

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