Canopy Adapted Dosing and Spray Application in 3D Crops

Make Use of the Potentials!

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AirCheck® Optimierung Luftverteilung für Sprühgeräte in Raumkulturen für Umweltschutz im Pflanzenschutz www.aircheck.eu

Norske Fruktdagar 2023, Vossevangen, 9-10. mars 2023

Spray Application in 3D-Crops: Where Do the Pesticides Go?

Without drift reduction

20 - 55% of a 100% dose applied, deposits at the target

Difference = 2,75 x

4 - 6% of a 100% dose applied, evaporate

2 - 5% of a 100% dose applied, drift outside the treated area

30 - 75% of a 100% dose applied, deposit on the orchard floor

Difference = 2,5 x

Spray Application in 3D-Crops: Where Do the Pesticides Go?

With 90% drift reduction

20 - 55%	of a 100% dose applied, deposits at the target
	Difference = 2,75 x
4 - 6%	of a 100% dose applied, evaporate
0,2 - 0,5%	of a 100% dose applied, drift outside the treated area
31,8 - 79,5%	of a 100% dose applied, deposit on the orchard floor
	Difference = 2,5 x

The questions

How much is 100%?

What causes spray deposition vary by a factor of 2,75?

Dose Rates in 3D Crops: The 100%-Question, Part I

How much was 100% (= registered dose rate) about 38 years ago, when spray drift reduction started and how much is 100% today?

Dose rates of molecules that were registered in 1985 and have still been registered in 2019 for 3,0 m canopy height:

Molecule	1985		2021		Difference
Captan	1,56	kg ha^{-1} (100%)	1,44	kg ha^{-1} (92%)	-7,7%
Dithianon	0,569	kg ha^{-1} (100%)	0,525	kg ha^{-1} (92%)	-7,7%
Mancozeb	2,400	kg ha^{-1} (100%)	2,250	kg ha^{-1} (94%)	-6,3%
Pirimicarb	0,375	kg ha^{-1} (100%)	0,375	kg ha^{-1} (100%)	0%
Copper	3,375	kg ha^{-1} (100%)	0,34	kg ha^{-1} (10,01%)	-89,99%

The facts: For products registered since approx 38 years, the registered dose rate (=100%) did not resp. not significantly change in these 38 years

The conclusion: If registered dose rates did not, resp not significantly change in the past 38 years, dosing and spray application have not been improved to reduce the release of molecules unwanted in the environment!

What has changed? Soil sediment from outside the orchard was moved to the treated area by drift reduction. This is possible because by law the treated area is considered extraterritorial land, not connected to the environment

Water Volumes in 3D Crops: The 100%-Question, Part II

How much was 100% (= compulsory water volume) about 38 years ago, when spray drift reduction started and how much is 100% today?

Water volumes of molecules that were registered in 1985 and have still been registered in 2019 for 3,0 m canopy height:

Molecule	1985	2019	Difference
Captan	1500 l/ha (100%)	1500 l/ha (100%)	0%
Dithianon	1500 l/ha (100%)	1500 l/ha (100%)	0%
Mancozeb	1500 l/ha (100%)	1500 l/ha (100%)	0%
Pirimicarb	1500 l/ha (100%)	≥ 1500 l/ha (100%)	≥ 0%
Copper	1500 l/ha (100%)	1500 l/ha (100%)	0%

Registered water volumes for pesticides in pome fruit in 2019 in Germany

6% ≥ 500 l ha^{-1} mKh
23% = 500 l ha^{-1} mKh
49% ≤ 500 l ha^{-1} mKh
20% 100 - 500 l ha^{-1} mKh.

At 3,0 m canopy heighht 80% of the products can be used at 1.500 l ha^{-1} or more!

Effects of the Registration on the Availability of Pesticides

Negative side effects on non target organisms increase as dose rates increase

High dose rates with high water volumes causing stronger side effects may

- prevent the registration of a new molecule
- favour withdrawal of a registered molecule

Lower dose rates with lower water volumes causing lower side effects may

- increase the chances for registration of a new molecule
- reduce the risk for withdrawal of a registered molecule

For molecules unwanted in the environment, dosing and spray application for registration trials and use in practise should be set to „State of the Art“ and not kept at „Worst Case“

a) to ensure the lowest possible dose rates in order to minimize pollution in general
and
b) to prevent an increasingly dangerous destabilization of crop protection in 3D-crops through a continuous loss of pesticides driven by avoidable excessive side effects

Lower dose rates are essential to reduce a further loss of products

The keys towards lower dose rates: the fan and the nozzles and their operation

Starting to Make Use of the Potentials: The Basic Steps

Step 1 Improve spray application (air distribution of the fan and its operation) to maximize the ratio of deposited versus released droplets and the quality of the spray deposit at the target (quantity, coverage, droplet density)

Step 2 After the optimization of spray application reference
a) dose rates are adapted to the new technique (= registration) and
b) dose rates are adapted to the target (= use in the orchard)

Step 3 After optimization of dosing and application is done, remaining spray drift needs to be reduced without killing steps 1 and 2.

The name:

Target-adapted dosing and spray application
(AOS = AirCheck®-Optimized Spraying)

Target-Adapted Dosing and spray Application: Which Droplets?

Properties of Droplets

(Droplet size affects property + = positively; — = negatively)

Big droplet	Property	Small droplet
(+)	Life span (not of interest)	(—)
—	Droplet density at the target	+
—	Potential to penetrate the target	+
—	Rear side deposition	+
—	Quality of spray cover	+
—	Visible residues	+
—	Risk for Phytotox	+
+	Potential for spray drift	—

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—	Rear side deposition	+
—	Quality of spray cover	+
—	Visible residues	+
—	Risk for Phytotox	+
+	Potential for spray drift	—
—	Controlability by the air flow	+
—	Electrostatic chargeability	+
—	Soil sediment	+
—	Water volume	+
—	Work rate	+
—	Consumption of pesticides	+
—	Consumption of Diesel	+
—	Noise emission	+
—	Working time	+
—	Cost	+

Quality of Spray Deposit: Visible Residues

- Small droplets produce a uniform and invisible spray covera

Quality of Spray Deposit: Visible Deposits

- Smal droplet remain at the position where they have been deposited and don´t coalesce

The only risk for visible deposits: a treatment on fruit wet from dew

Quality of Spray Deposit: Phytotoxicity

The time required for the spray cover to dry off determines the risk for phytotox

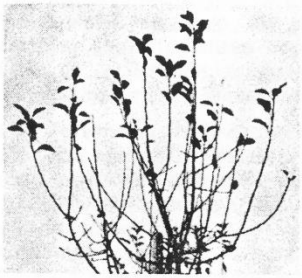


Abb. 7: Gespritzt mit 0,15 %/2000 ml Cu-Brühe

Spray trials with copper (Behlen, 1972)

The effect of droplet size on phytotox (variety = Golden Delicious)

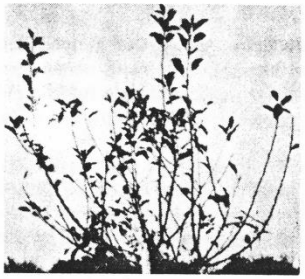


Abb. 8: Normal gesprüht mit 0,75 %/400 ml Cu-Brühe

3 g Copper per tree have been applied with decreasing droplet size and water volume per tree

.

Abb. 9: Feingesprüht mit 7,5 %/40 ml Cu-Brühe mit Synergid-Zusatz

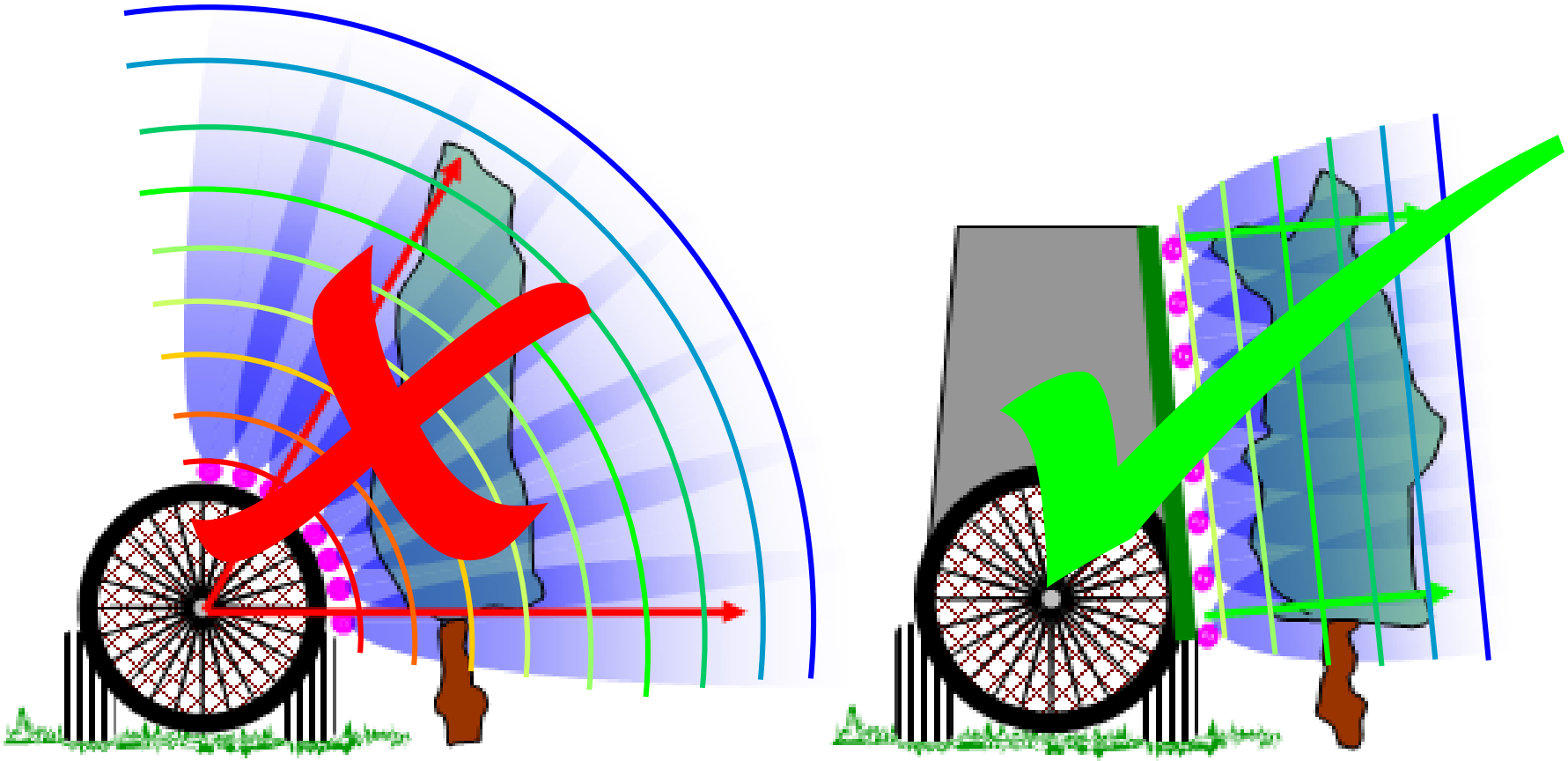
The lower droplet size and water volume, the more leaves remained on the tree

Canopy Adapted Spray Application: Which Fan Type?

The air stream is the means for transporting the droplets into the target structure, but must not remove them from there. **The fan is not an air force!**

All negative effects increase and all positive effects decrease with an increasing vertical angle of the air flow and increasingly excessive fan speed!

Quality of spray application is determined by a) **fan type and adjustment of the farm specific working height** (task of the manufacturer)



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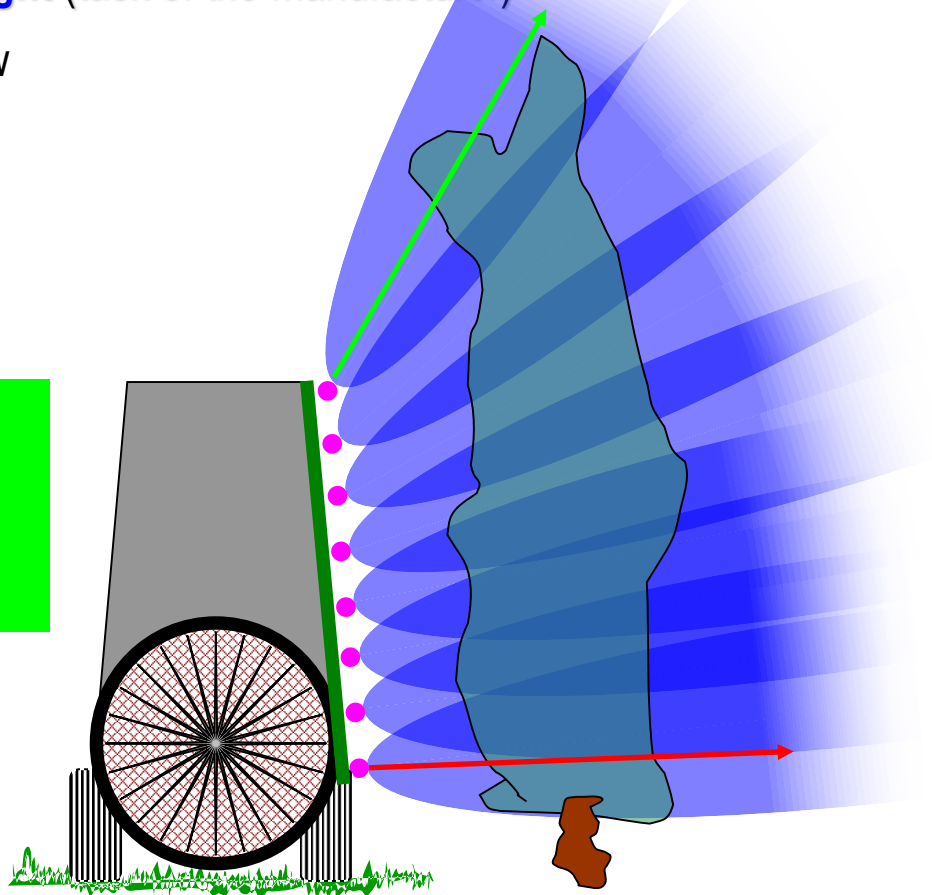
Important: To adapt the horizontal reach of the air flow to canopy width without a reduction of the working height, the vertical angle at the top of the fan already by construction needs to be as low as possible (< 40°) (axial fan: 60°+)

Tall crops at narrow row distances require tall fan types to keep the angle of the air flow low!



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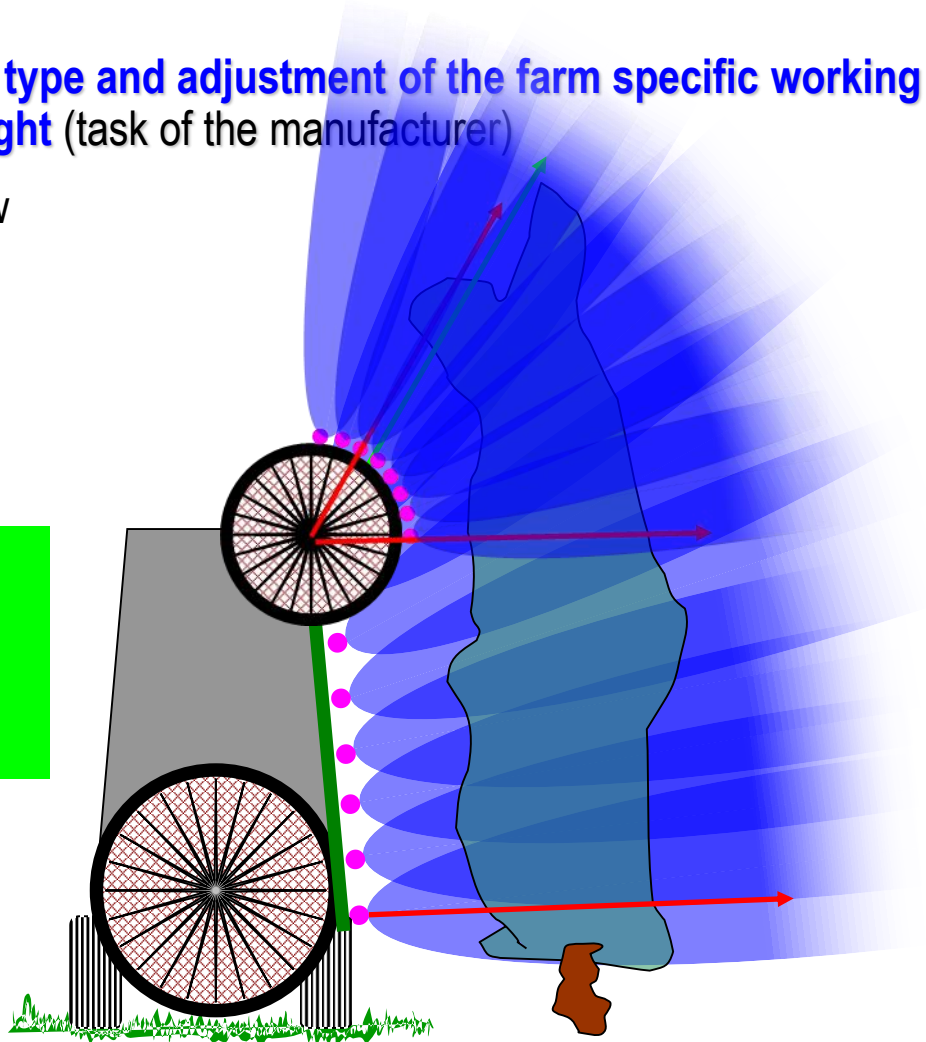


A High Angle of the Air Flow: Cause of damages at the Tree Top

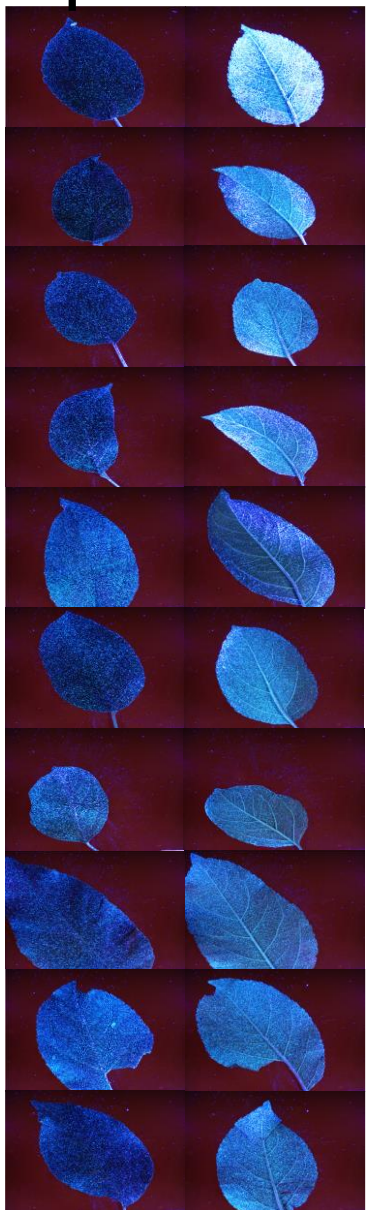
Top of the tree

Upper leaf surface

Quantity of deposit, droplet density and coverage are always lower compared to the lower leaf surface and decrease with increasing sampling position.

The upper leaf surface at the top of the tree are therefore and because of gaps in the spray cover on highest risk for fungal infections (scab) and pest attack (aphids, leaf roller).

This risk increases as the angle of the air flow and fan speed increase!



Lower leaf surface

Quantity of deposit, droplet density and coverage are always higher compared to the upper leaf surface and increase with increasing sampling position

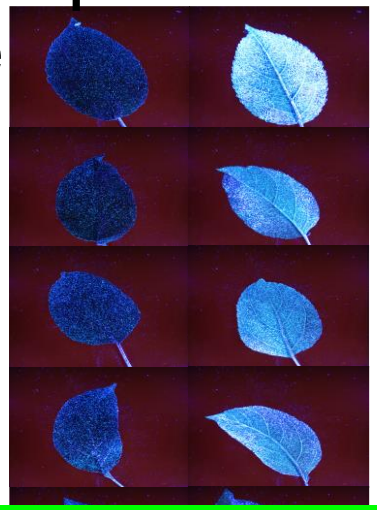
On the lower leaf surface there´s a manyfold over deposition, but only a very low risk for fungal infections (scab). The over deposition of the lower leaf surface increses with the angle of the air flow and fan speed and is a waste.

Applied with a cross flow fan and small droplet hollow cone nozzles

A High Angle of the Air Flow: Cause of damages at the Tree Top

Top of the tree

Upper leaf surface



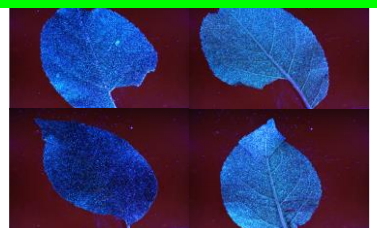
Lower leaf surface

Quantity of deposit, droplet density and coverage are always lower compared to the lower leaf surface and decrease with increasing sampling position.

Quantity of deposit, droplet density and coverage are always higher compared to the upper leaf surface and increase with increasing sampling position

This problem develops, when sprayer and crop characteristics do no more fit and is home made!

With a continuing loss of pestices in 3D crops and increasing replacement by low efficacy plant strengtheners we cannot afford home made problems any longer!



Applied with a cross flow fan and small droplet hollow cone nozzles

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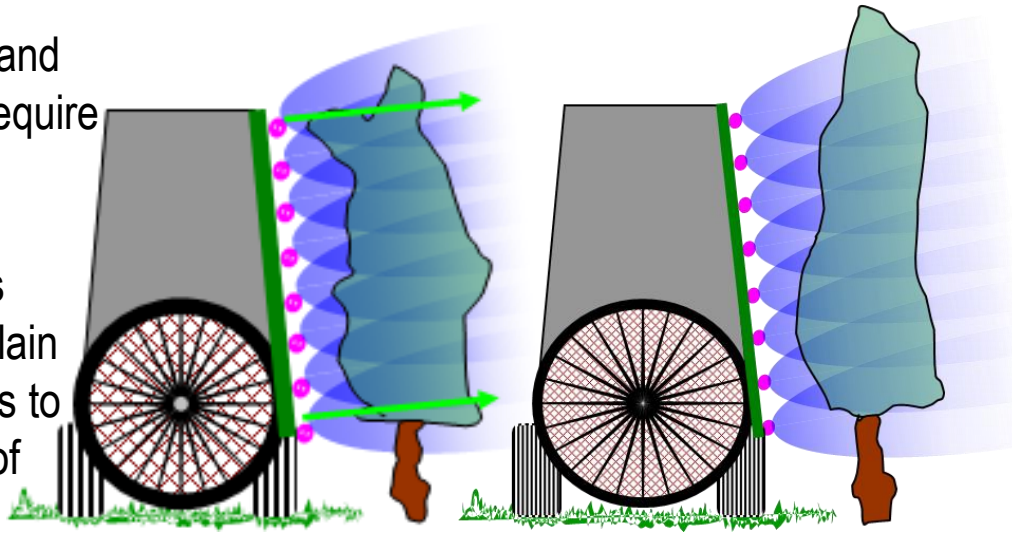
All negative effects increase and all positive effects decrease with an increasing vertical angle of the air flow and increasingly excessive fan speed!

Quality of spray application is determined by a) **fan type and adjustment of the farm specific working height** (task of the manufacturer)

Important: To adapt the horizontal reach of the air flow to canopy width without a reduction of the working height, the vertical angle at the top of the fan already by construction needs to be as low as possible (< 40°) (axial fan: > 55°)

Also an allmost uniform spray deposit at the upper and lower leaf surfaces and a high deposition efficacy require an angle of the air flow as low as possible.

Since good fan types with cross flow characteristics have a max angle of the air flow much lower than plain axial fans, the suitability of a fan type for the orchrds to be treated needs to be assessed before purchase of the sprayer!



The AirCheck®-Fan Type Selection Aid: Properties of Fan Types

The AirCheck™-White List 2023

Fan Types for Highly Efficient and Resource Friendly Crop Protection in 3D-Crops

Constituted on January 11, 2023

Fan Type	Maximum working height at 3,0 m row distance m	Maximum angle of the air flow Degree	Usable air flow $m^3_{eff}\ h^{-1}$	Usable air flow per metre maximum working height $m^3_{eff}\ h^{-1}\ m^{-1}$	Power consumption at PTO kW	Diesel consumption at fuel tank $l\ h^{-1}$	CO_2-emissions $kg\ h^{-1}$	**Energy efficiency** Diesel consumption per m³ usable air flow per hour $ml\ m^{-3}_{eff}\ h^{-1}$	Noise emission dB (A)	Drift reduction classification (JKI)* %	AirCheck®-air distribution quality: Classification
Zupan DT-V	2,4	26	45.120	18.800	7,70	2,59	6,87	0,057	84	75	Air Distribution
Weber QU15 H	2,5	-1	31.181	12.472	5,35	1,80	4,77	0,058	79	90 / 75*	Low Loss Spray Application
Lochmann 80UQW 2	2,6	17	51.013	19.620	10,96	3,69	9,78	0,072	84	75	Air Distribution
Weber QU16 H	2,8	5	38.256	13.663	7,73	2,60	6,90	0,068	78	90	Low Loss Spray Application
Wanner ZA28	2,8	39	41.341	14.765	3,12	1,05	2,78	0,025	83	90	Low Loss Spray Application
Lochmann 80UQ2-A	3,3	-2	50.320	15.248	12,70	4,28	11,33	0,085	87	75 / 95 (AFC) / 75**	Air Distribution
Weber QU17 H	3,3	5	43.376	13.144	7,73	2,60	6,90	0,060	79	50	Low Loss Spray Application
Weber QU15,5-12 H	3,3	21	47.011	14.246	9,26	3,12	8,26	0,066	78	75	Low Loss Spray Application
Zupan DT CR-O	3,4	43	53.009	15.591	19,20	6,46	17,13	0,122	87	75	Air Distribution
Wanner H63	3,5	15	41.221	11.777	7,01	2,36	6,26	0,057	83	95	Low Loss Spray Application
Lochmann 90UQH2-A	3,5	41	68.904	19.687	16,70	5,62	14,90	0,082	90	95 / 75**	Low Loss Spray Application
Waibl Q / 09	3,5	45	61.482	17.566	11,00	3,70	9,81	0,060	87	75	Air Distribution
Wanner ZA32	3,5	49	59.197	16.913	8,56	2,88	7,64	0,049	84	90 / 75*	Low Loss Spray Application
Zupan DT MAXI-O	3,6	49	72.737	20.205	18,10	6,09	16,15	0,084	85	75	Air Distribution
Zupan DT-O	3,7	49	56.205	15.191	8,70	2,93	2,33	0,052	80	95 (LMR) / 75**	Low Loss Spray Application
Wanner 36GA nA	3,7	52	74.800	20.216	11,75	3,96	10,48	0,053	84	90	Low Loss Spray Application
Lochmann 80UQ 2	3,8	50	60.820	16.005	11,10	3,74	9,90	0,061	85	75	Air Distribution
Lochmann 90Q 2	3,9	55	69.774	17.891	17,30	5,82	15,44	0,083	86	90	Low Loss Spray Application
Lochmann 90UQ 2	3,9	56	81.449	20.884	17,30	5,82	15,44	0,072	86	75	Air Distribution
Wanner 36GA mhA	4,0	53	69.455	17.364	11,75	3,96	10,48	0,057	84	75	Air Distribution
Wanner 42GA	4,0	55	107.871	26.968	16,65	5,61	14,86	0,052	89	95	Low Loss Spray Application
Lochmann 90QB 2	4,0	59	75.184	18.796	19,60	6,60	17,49	0,088	87	75	Air Distribution
Lochmann 90UQH 2	4,1	53	74.521	18.176	16,40	5,52	14,63	0,074	87	75	Air Distribution

Please note that the listing of a fan type in the **AirCheck®**-white list only confirms the basic suitability of this fan **type** for target adapted spray application. This does not automatically apply to any individual fan from the series due to unavoidable deviations of production and assembly of air ducting components and the necessity to adjust the air distribution for canopy adapted spray application to the requirements of the buyer through an individual adjustment and verification. This suitability is only confirmed by the positive air distribution protocol of the individual fan according the actual **AirCheck®**-guidelines, the entering of the individual number of an **AirCheck®**-test badge in this protocol, and the affixing of this test badge on the sprayer.

The AirCheck®-Fan Type Selection Aid: 3 Steps for the Best Fan

The procedure for interested parties/customers:

1) In the orchards:	recording orchard data (row distance, crop height, special cases)
2) At www.aircheck.eu:	Input of address data Input of orchard data (row distance, crop height, special cases) **Result:** Listing of potentially suitable fan types from the white list that can provide a vertical angle of the air flow equal or higher than the max angle
3a) Interested parties:	Select one or more potentially suitable fan types and get the assessments sent exclusively to your mail address
3b) Customers:	Select the most suitable fan type (preferebly with the lowest vertical angle possible and add all other components to the sprayer to be purchased Order the sprayer at the hardware store Initiate automatic transfer of the assessments with the data for adjustment of air and liquid distribution to the sprayer manufacturer
In NO case:	**Buy the sprayer first and get air and liquid vertical distribution adjusted after purchase!!!**
Why?	**For cross flow fan types with a mnimized vertical angle of the air flow it needs to be checked before the purchase if the fan type can at all treat all the orchards up to the top of the tree**

The AirCheck®-Fan Type Selection Aid: Step 1 for the Best Fan

Assessment of orchard data: Mandatory requirement to find the orchard that requires the highest angle of the air flow!!

Farm Specific Adjustment of the Air Distribution of Sprayers for 3D-Crops

Record Sheet of Orchard Data for Input at www.aircheck.eu

Farm: _____ Date: _____

Combination*	Information for your Overview e. g. name, variety, location, training system **Please note:** This column is only for your overview! Information that can be used for identification and localisation of orchards as name, geo location, field number, orchard code, acreage, variety, owner, etc. are not required for air distribution adjustment at www.aircheck.eu and can consequently not be typed in!	Mandatory parameters Row distance m	 Tree height m	Data for special orchard designs (Terrace, slope, V-System, hedge, flat canopy, spheric canopy) Max. vertikal difference bewteen upper and lower tree row left and right of one alley way Terrace m	 Slope (perpedicular) m	V-system, hedge row, flat canopy**, spheric canopy** Protrusion m
Example	Behind the barn / McIntosh / hedge row	4,50	3,2		0,5	0,9
1						
2						
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26						
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28						
29						

* = All combinations (= orchards) that have identical values for row distance, tree height and eventually also the data of the special cases, need to be typed in only once!
** = From flat canopies and spheric canopies, tree height is equivalent to the height of the max canopy width and therefore needs to be measured from the ground to this height!
*** = A protrusion at the top of the tree needs to be measured and recorded in case it is larger than approx 5% (=1/20) of the row distance!

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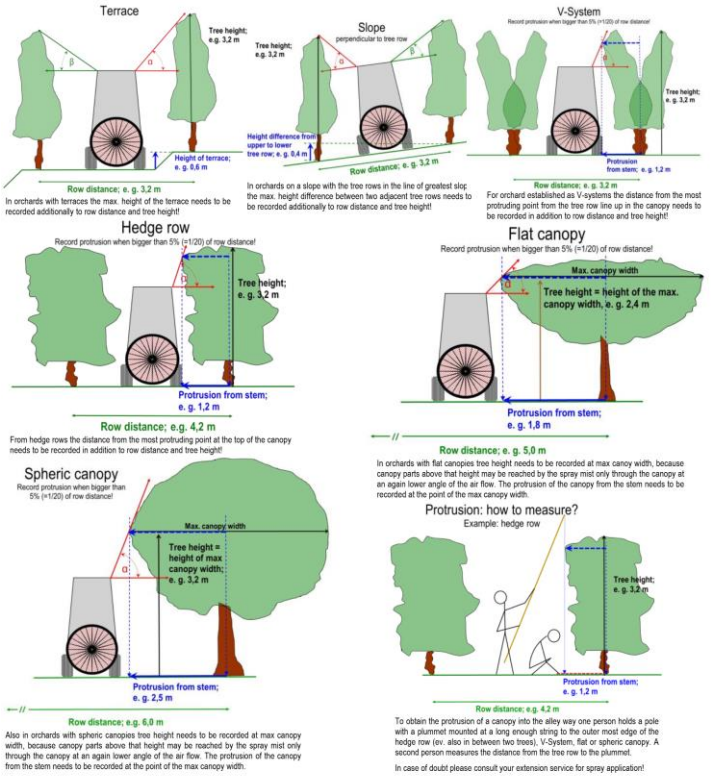
Farm Specific Adjustment of the Air Distribution of Sprayers for 3D-Crops

Record Sheet of Orchard Data for Input at www.aircheck.eu

Assessment of data from special orchard designs

For finding the best suited fan type and enable the correct adjustment of air and liquid vertical distributions to the orchards to be sprayed at your operation, data that affect the angle of the air flow in order to completely spray every orchard design of the operation, are required. Anyhow orchard designs that are identical in several orchards of the operation and also do not vary by one or more of the special cases, need to be recorded at www.aircheck.eu just once. Also a certain order of the orchards is not required.

On almost flat land the actual canopy design of a slim spindle or even super spindle as in vine growing with its slim canopies and limited height is sufficiently characterized by the recording of row distance and plant height (= from the orchard floor to the top of the plant).
Terraces or more slopy terrain and special training systems as e.g. V-systems in pome fruit or hedge rows in stone fruit require the assessment of one or two additional parameters, because these special cases increase the required vertical angle of the air flow and therefore - if unconsidered - may result in incomplete coverage of structures in the upper part of the canopy, very likely resulting in serious attack of pests and diseases. These special cases include height differences from tree row to tree row in terraces and slops but also the protrusion of canopy structures in high and broad canopy systems as in stone fruit into the alley way. Canopy width does not need to be measured for adjusting the air distriubution, because this parameter is addressed at spray application by forward speed and fan speed. The following graphs should enlighten the assessment of these eventually additionally required parameters - **printed in blue**. If applicable, please trim your trees a bit, so that no shoots and suckers are protruding far into the alley way!



The AirCheck®-Fan Type Selection Aid: Step 2 for the Best Fan

Orchard data input at www.aircheck.eu: Mandatory requirement to find the orchard that requires the highest angle of the air flow!!

Hinweise zu Dateneingabe und Fehlermeldungen (vor der ersten Benutzung bitte lesen!)

Allgemeine Anlagendaten		Sonderformen (Terrasse, Hanglage, V-System, Hecke, Tellerkrone, Rundkrone)		
		Maximaler Höhenunterschied obere zu untere Baumreihe einer Fahrgasse		Überstand
Reihenabstand m	Kulturhöhe m	Terrasse m	Hanglage (quer) m	V-System, Hecke, Tellerkrone, Rundkrone m
z.B. 3,0 *	z.B. 3,5 *	z.B. 3,5 *	z.B. 3,5 *	z.B. 3,5 *

Kombination speichern

3.5	3.0			0.3	x
3.3	3.0			0.3	x
3.4	3.4			0.5	x
3.3	3.2			0.3	x
3.4	3.0			0.3	x
3.7	3.2			0.3	x

Anzahl potenziell geeigneter Gebläsetypen: 8

Zurück Weiter

The AirCheck®-Fan Type Selection Aid: Step 3 for the Best Fan

Order release at www.aircheck.eu for the adjustment of air and liquid distribution based on the orchard of the farm that requires the highest angle of the air flow

AirCheck® Optimierung Luftverteilung für Sprühgeräte in Raumkulturen für Umweltschutz im Pflanzenschutz www.aircheck.eu

Die Optimierung der Luftverteilung von Sprühgeräten in Raumkulturen

Für Umweltschutz im Pflanzenschutz

AirCheck® c/o Dr. Peter Triloff,
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Zeitstempel: 09.09.2020 - 16:49 Uhr

Auswertung:

Kunde: Peter Triloff
Gewählter Gebläsetyp: Wanner 36GA mhA
Hersteller: Wanner
Kultur: Obstbau
Zeitstempel: 08.09.2020 - 14:24 Uhr

Auftragsfreigabe

Sehr geehrte Damen und Herren,

unten aufgeführter Besucher von www.aircheck.eu hat nachstehende Auswertung der von ihm eingegebenen Parzellendaten für die Einstellung der Gebläseluft-Vertikalverteilung des aus der aktuellen **AirCheck®**-Positivliste gewählten Gebläsetyps an die ab Seite zwei aufgelisteten Kombinationen aus Reihenabstand und Kulturhöhe mit eventuellen Zusatzinformationen zu Sonderformen angefordert und Ihnen mit dieser Nachricht zukommen lassen.

Falls nachstehender Kunde ein Sprühgerät aus Ihrem Haus bestellt hat, entspricht diese vom Kunden übermittelte Nachricht der Freigabe des ev. kostenpflichtigen Auftrags zur Einstellung der Gebläseluft- und ev. auch der Flüssigkeits-Vertikalverteilung anhand der zum Zeitpunkt ihrer Erstellung gültigen **AirCheck®**-Richtlinie auf die Angaben des Kunden ab Seite 2 dieser Nachricht! Falls zu dieser Freigabe keine Bestellung eines Sprühgerätes vorliegt, kann die Bestellung noch bei dem zuständigen Handelsunternehmen liegen.

Aus Sicherheitsgründen sollten Sie mit dem Auftraggeber noch einmal Rücksprache halten!

Bitte beachten: Dieser Auftrag zur Einstellung der Luft- und ev. Flüssigkeits-Vertikalverteilung kann innerhalb von 21 Tagen ab dem Datum der Bestellung des Sprühgerätes (siehe Auftragsbestätigung) ohne Angabe von Gründen durch den Auftraggeber kostenfrei storniert werden!

Nachstehend finden Sie die gewünschten Informationen.
(Die Einwilligung des Auftraggebers zu Datennutzung und Datenschutz durch www.aircheck.eu, die zutreffenden Partnerbetriebe und Partnerinstitutionen wurde auf dem Online-Formular von www.aircheck.eu erteilt!)

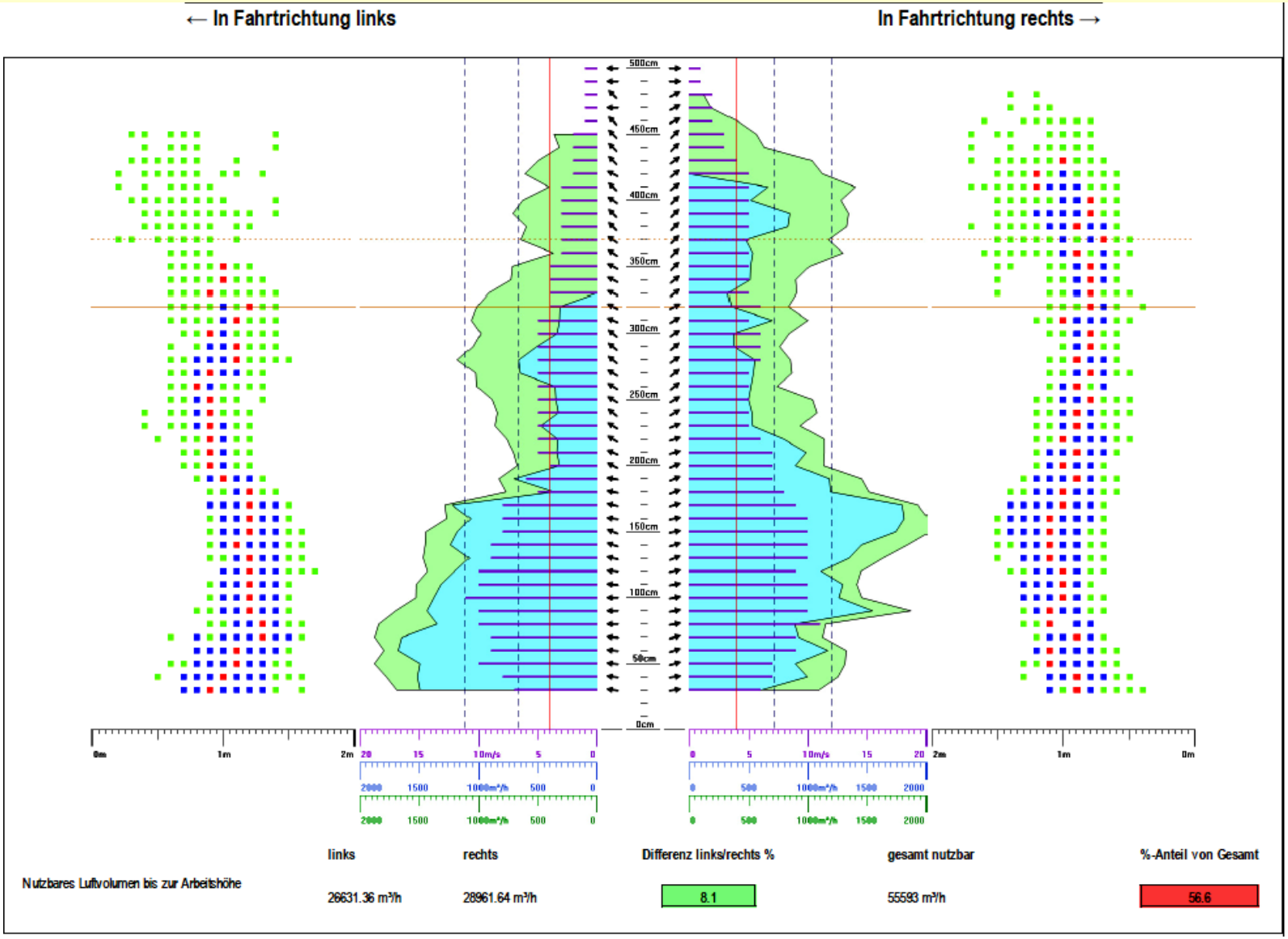
Parzellendaten:

Allgemeine Anlagendaten		Sonderformen (Terrasse, Hanglage, V-System, Hecke, Tellerkrone, Rundkrone)			Für die Einstellungen am Luftprüfstand	
		Maximaler Höhenunterschied obere zu untere Baumreihe einer Fahrgasse		Überstand		
Reihenabstand	Kulturhöhe	Terrasse	Hanglage (quer)	V-System, Hecke, Tellerkrone, Rundkrone	und die Kombination erforderlicher Strömungswinkel	erforderliche Arbeitshöhe
m	m	m	m	m		
3	3.5				43	3.5
3.2	3.3				36	3.2
4.5	4			0.7	52	3.9
3.3	3.6				42	3.5
3.5	3.6		0.4		49	3.8
3	2.6	0.6			35	3.2
3.4	3.6			0.4	50	3.8
2.8	3.2				37	3.3

Die oben aufgelisteten Kombinationen aus Reihenabstand und Bestandshöhe ergeben folgende Parameter für die Einstellung der Vertikalverteilung von Gebläseluft und Flüssigkeit auf dem Luft- bzw. Flüssigkeitsprüfstand:

Gebläsetyp: Wanner 36GA mhA
Messabstand (Obstbau): 1,5 m
Gebläsedrehzahl: 460 min^{-1} in Getriebestufe II
Grenzwert nutzbare Luft: 4,0 m s^{-1}
Erforderliche Arbeitshöhe: 3.9 m
Erforderlicher Strömungswinkel: 52°

The Air Distribution of Fans in Use on Fruit Farms

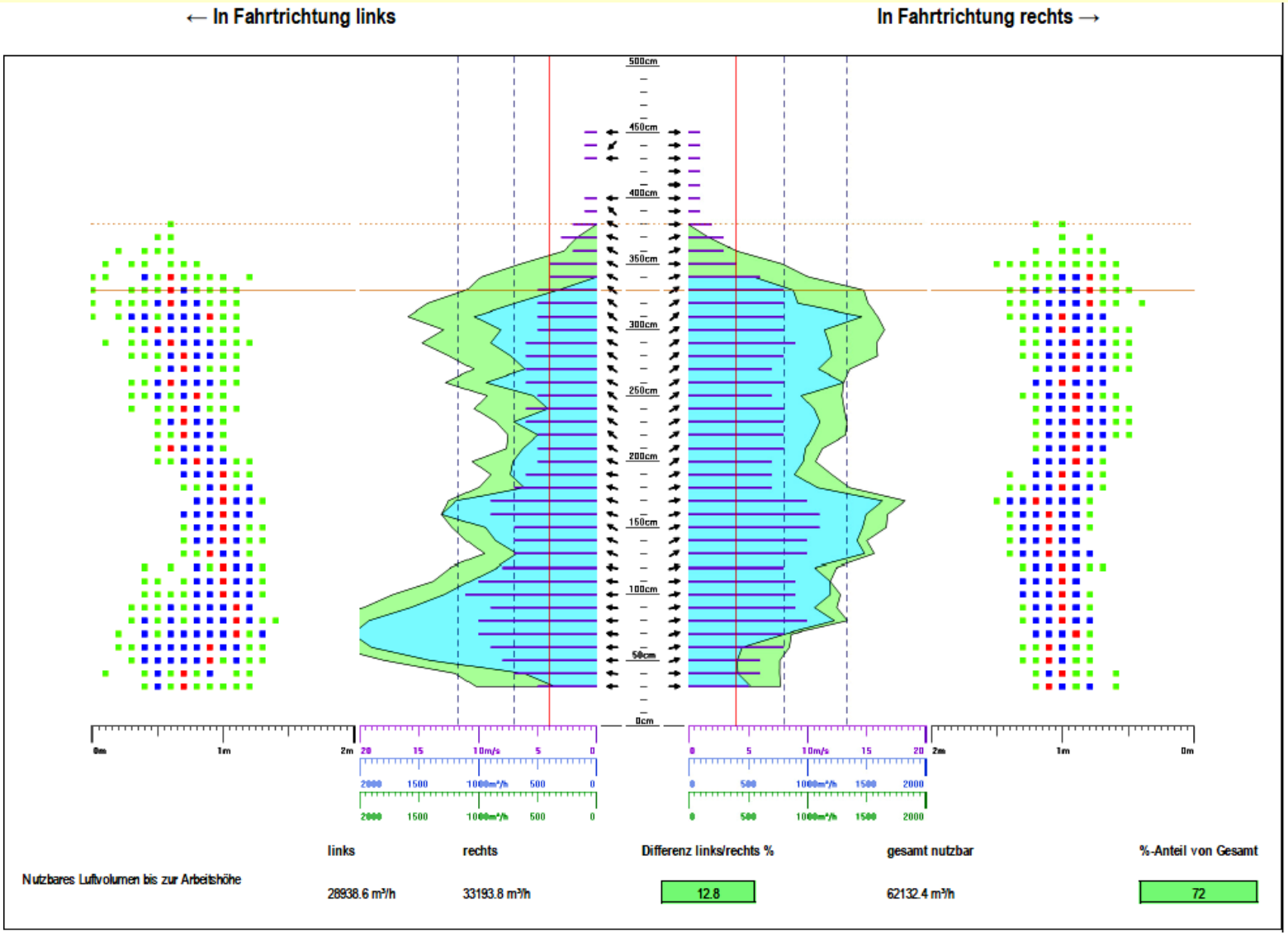


Axial fan with tower directly from the manufacturer

Blue area: Usable air flow with sufficient air speed

Green area: Non usable air flow with too low speed already at the air bench

The Air Distribution of Fans in Use on Fruit Farms

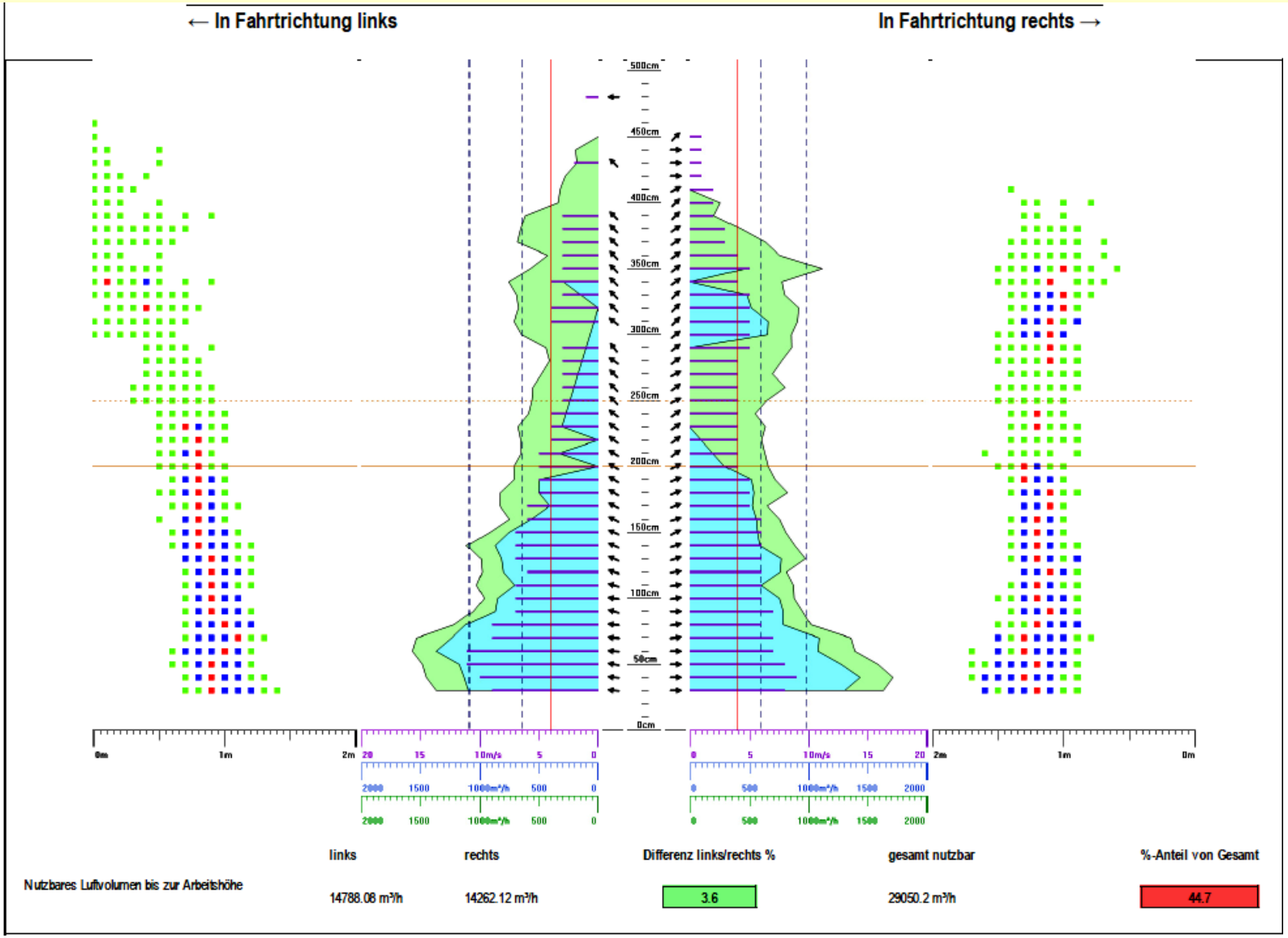


The same fan after the best possible adjustment (not yet passed the test)

Blue area: Usable air flow with sufficient air speed

Green area: Non usable air flow with too low speed already at the air bench

The Air Distribution of Fans in Use on Fruit Farms



The explanation of continuous scab attack after purchase of the sprayer

Blue area: Usable air flow with sufficient air speed

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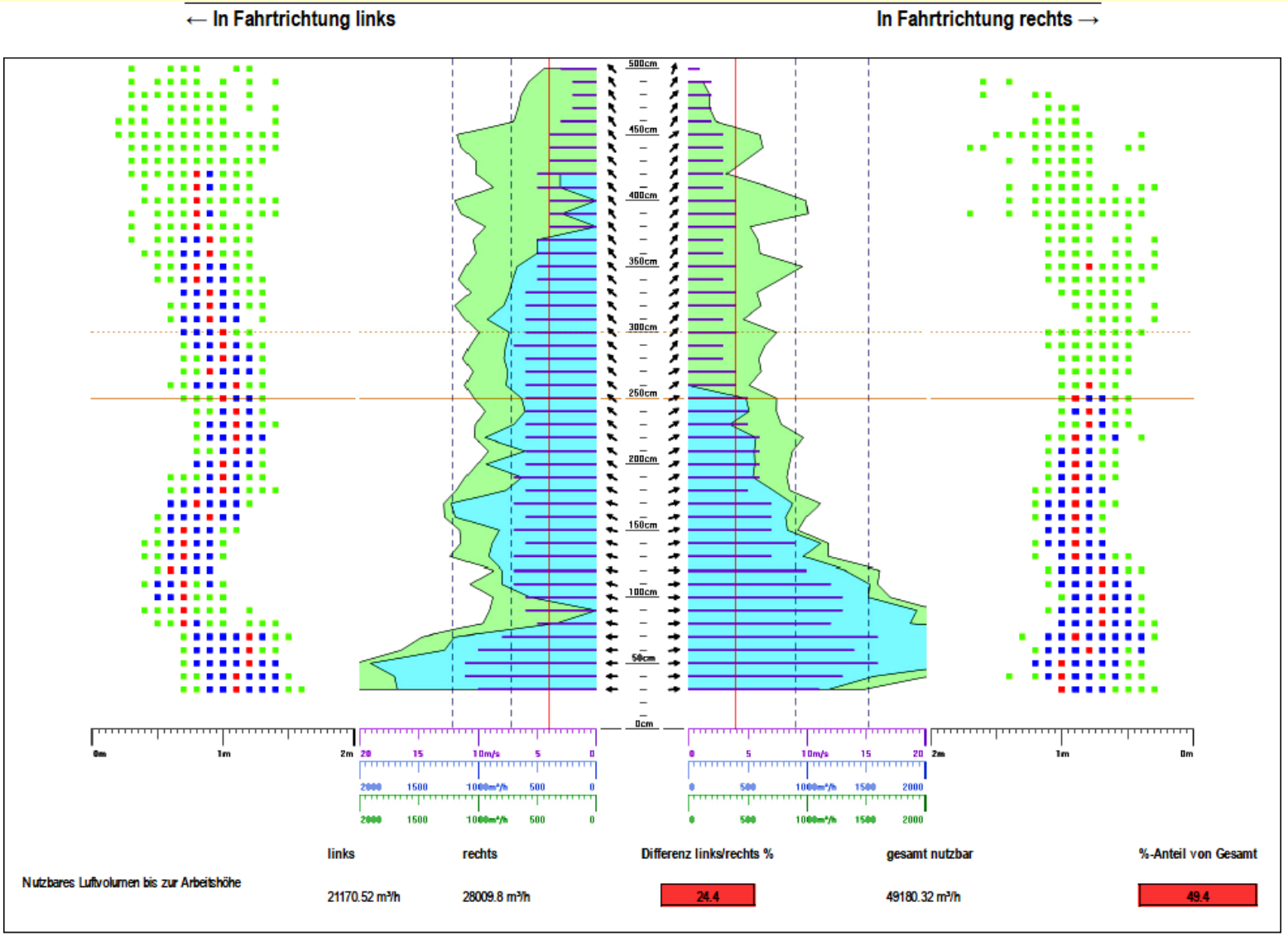
The Air Distribution of Fans in Use on Fruit Farms

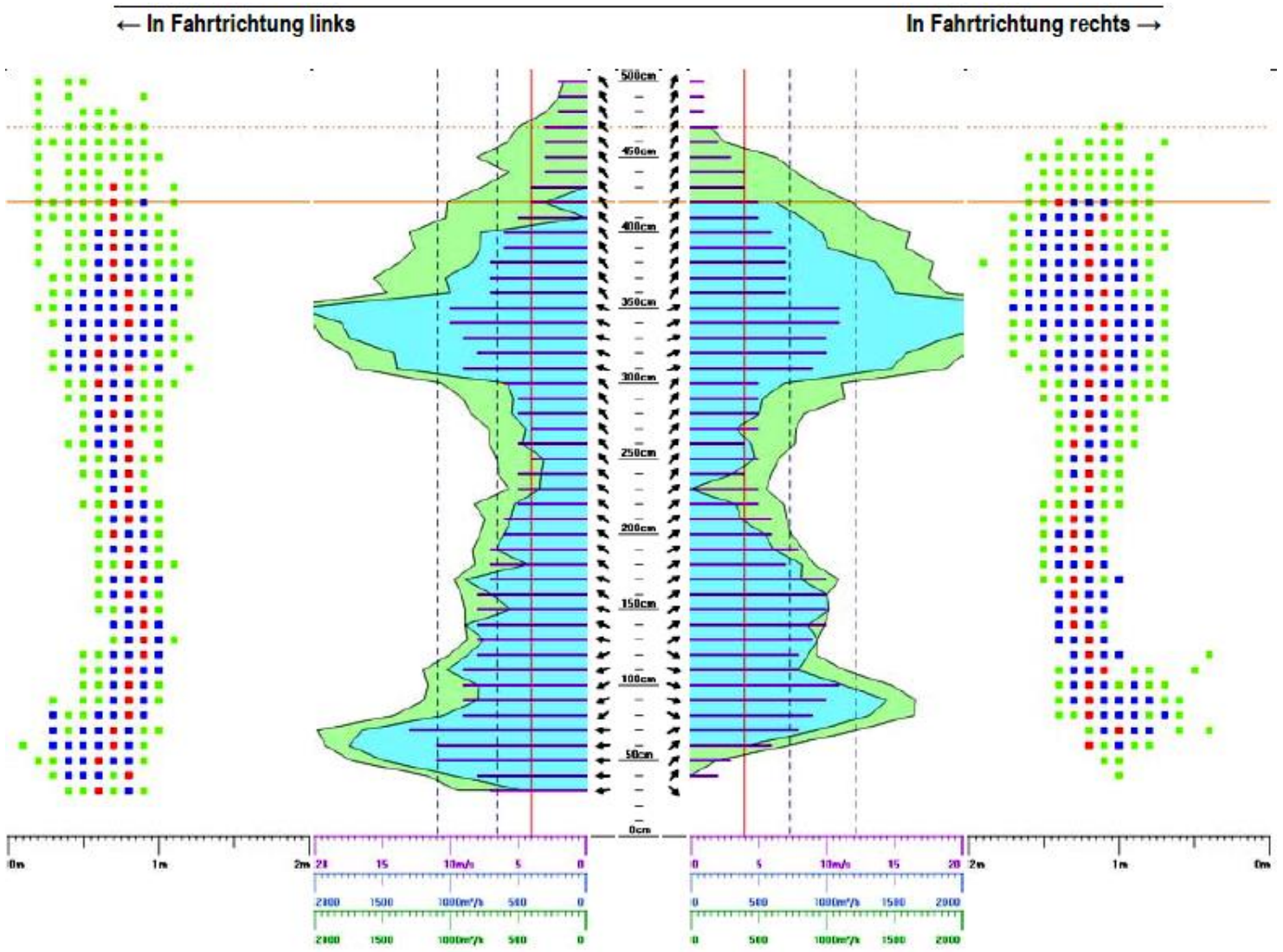


Unsuitable fan type (uneven working heights left and right)

Blue area: Usable air flow with sufficient air speed

Green area: Non usable air flow with too low speed already at the air bench

The Air Distribution of Fans in Use on Fruit Farms

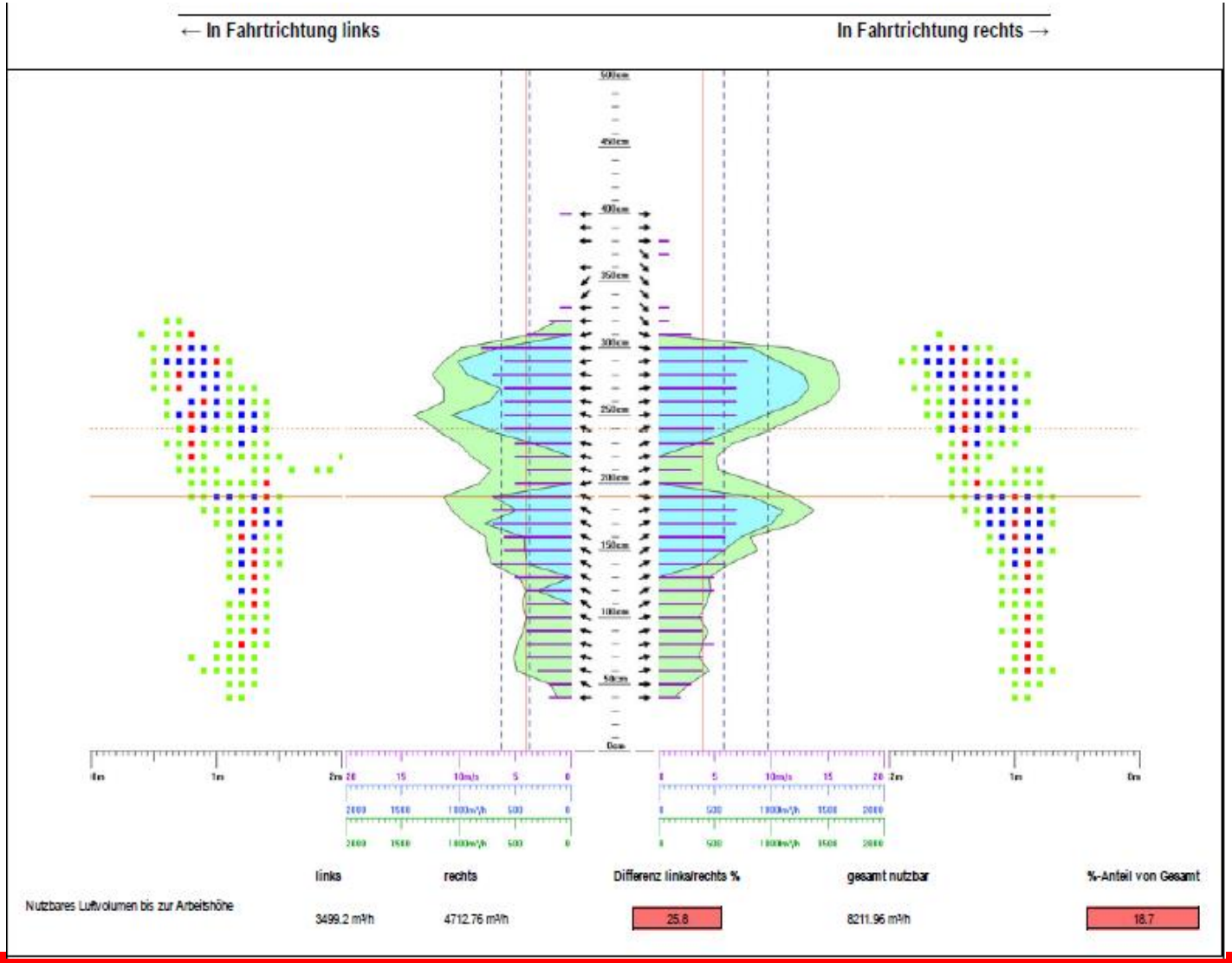


Tower sprayer with axial fan: The two air jets require strange orientations of the nozzles above and below the jets to obtain a uniform liquid distribution

Blue area: Usable air flow with sufficient air speed

Green area: Non usable air flow with too low speed already at the air bench

The Air Distribution of Fans in Use on Fruit Farms



Non usable fan type (poor air flow and air distribution, may only be operated at 540 PTO II and max. 6 km/h)

Blue area: Usable air flow with sufficient air speed

Green area: Non usable air flow with too low volume already at the air bench

The AirCheck®-Fan Type Selection Aid: The Result (Protocol)

Initiative 'Optimierung Luftverteilung für Sprühgeräte in Raumkulturen'

Protokoll Gebläseprüfung

Aus Messwerten nach durchgeführten Änderungen

Prüfstelle	Gebläse-Prüfung		Geräte-Eigentümer
Marktgemeinschaft Bodenseeobst eG	**Prüfdatum:**	12.05.2020 13:08:58	Hubert Lochmann
Albert-Maier-Str. 6	**Protokoll-ID:**	MABO_W 000014	Vilpianerstr.2
88045 Friedrichshafen	**Plaketten-Nr:**		Nals (BZ)
	Prüfer:	P.Triloff	

Sprühgerät

Sprühgeräte-Typ:	Lochmann RPS 10/90
Serien-Nummer:	013017
Baujahr:	2019
Gebläse-Typ:	UQH2A
Messabstand:	1.5 m
Prüfdrehzahl (Zapfwelle):	460 U/min
Prüfdrehzahl (Lüfter) *):	0 U/min
Luftverteilung berechnet mit:	v x (hor. Komponente)
Auswertebereich ab:	30 cm
Arbeitshöhe:	3.5 m
Strömungswinkel auf 3.5 m:	li 31°, re 45°
Luftvolumen gesamt:	70681 m³/h
Maximale Luftgeschwindigkeit:	12.2 m/s bei 1.1 m
Prüfergebnis:	**Bestanden**

Umweltdaten (Typenprüfung)

Energie-Verbrauch

Lüfterdrehzahl	Energieverbrauch		CO2-Emissionen	Spezifischer Energieverbrauch	
U/min	Treibstoff l/h	kWh/h	kg/h	Wh/m³ eff/h	Treibstoff ml/m³eff/h
885	0.76	2.26	2.02	0.136	0.046
1922	5.82	17.3	15.44	0.248	0.083

Lärm-Emissionen

Gebläse-Typ	Lüfterdrehzahl U/min	
	885	**1922**
Emissionen (dbA)	71	86

*) Bitte beachten: Die Prüfdrehzahl entspricht nicht der Arbeitsdrehzahl in der Kultur. Arbeitsdrehzahl und Fahrgeschwindigkeit müssen an die jeweilige Kultur (Reihenabstand und Kronentiefe) angepasst werden.

Ergebnisse Gebläseprüfung

nach durchgeführten Änderungen

Lüfterdrehzahl (Prüfdrehzahl):	0 U/min
Maximal behandelbare Baumhöhe (Arbeitshöhe):	3.5 m
Strömungsrichtung auf Arbeitshöhe:	li: 31° re: 45°

Teilbreite (in Fahrtrichtung)	links	rechts	Grenzwerte	eingehalten	nicht eingehalten
Luftvolumen insgesamt:	**36071 m³/h**	**34610 m³/h**			
Nutzbares Luftvolumen bis zur Arbeitshöhe:	**28608 m³/h 79%**	**26766 m³/h 77%**	≥ 2 Messpositionen/Messhöhe bei ≥ 4.0 m/s Luftgeschwindigkeit = Mindest-Luftvolumen		
Schwankungen des nutzbaren Luftvolumens	**20.6 % VK**	**18.8 % VK**	Höchstwert Schwankung: 35% VK (VK=Variationskoeffizient)		
Ausreißer bei dem mittleren nutzbaren Luftvolumen	**15.2 %**	**9.1 %**	Max. 30% der Messhöhen/Arbeitshöhe u. Teilbreite außerhalb Toleranzbereich von ± 25%		
Nicht-nutzbares Luftvolumen bis zur Arbeitshöhe	**6026 m³/h 16.7%**	**6592 m³/h 19%**	Aufgrund zu niedriger Luftgeschwindigkeit (< 4.0 m/s). Höchstwert: 20 %		
Nicht-nutzbares Luftvolumen von 3.5 m - 4 m Höhe	**1436 m³/h 4%**	**1252 m³/h 3.6%**	Höchstwert: 15 %	Beide Werte bestimmen im Wesentlichen das Abdriftrisiko!	
Nicht-nutzbares Luftvolumen über 4 m Höhe	**0 m³/h 0%**	**0 m³/h 0%**	Höchstwert: 5%		
Luftgeschwindigkeiten bis zur Arbeitshöhe	**7.6 / 10 m/s**	**8.5 / 12.2 m/s**	Durchschnitt und Maximum		
Schwankungen Luftgeschwindigkeit bis zur Arbeitshöhe	**16.8 % VK**	**22.9 % VK**	Höchstwert Schwankung: 35 % VK		

	gesamt	gesamt nicht nutzbar	gesamt nutzbar	Differenz (links/rechts) nutzbares Luftvolumen
Luftvolumen	**70681 m³/h**	**15307 m³/h 21.7%**	**55374 m³/h 78.3%**	**6.4%**
		Grenzwert: < 40 %	Grenzwert: > 60 %	Grenzwert: 15 %

Bild Sprühgerät

Kommentar Prüfpersonal

Typenprüfung 460 U/min, Stufe II

Initiative 'Optimierung Luftverteilung für Sprühgeräte in Raumkulturen'

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Sprühgerät

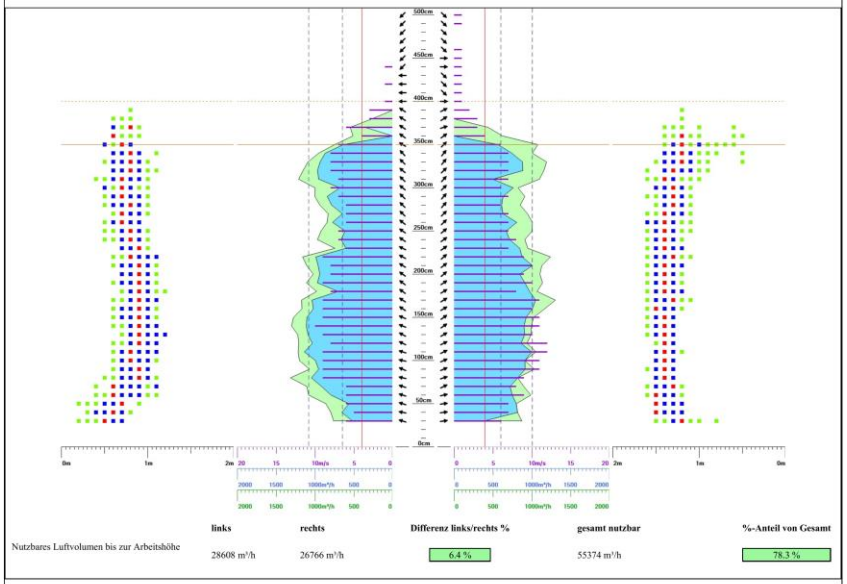
Sprühgeräte-Typ:	Lochmann RPS 10/90
Serien-Nummer:	013017
Baujahr:	2019
Gebläse-Typ:	UQH2A
Berechnet mit:	v x (hor. Komponente)
Arbeitshöhe:	3.5 m (Grenzwert: 4.0 m/s)
Strömungswinkel auf 3.5 m:	31° links, 45° rechts
:	
Prüfergebnis:	Bestanden

Gebläse-Einstellung

Zapfwellendrehzahl:	460 U/min
Gebläsestufe:	II
Prüfdrehzahl (Lüfter) *):	0 U/min
Messabstand:	1.5 m

*) Bitte beachten: Die Prüfdrehzahl entspricht nicht der Arbeitsdrehzahl in der Kultur. Arbeitsdrehzahl und Fahrgeschwindigkeit müssen an die jeweilige Kultur (Reihenabstand und Kronentiefe) angepasst werden.

← In Fahrtrichtung links **In Fahrtrichtung rechts →**



	links	rechts	Differenz links/rechts %	gesamt nutzbar	%-Anteil von Gesamt
Nutzbares Luftvolumen bis zur Arbeitshöhe	28608 m³/h	26766 m³/h	6.4 %	55374 m³/h	78.3 %

Legende

Grenzwerte Gebläseluft

Grenze zur Umgebungsluft	1.5 m/s
Anzahl Messpositionen/Messhöhe ≥	2.0
mit Mindest-Geschwindigkeit der nutzbaren Luft von	4.0 m/s
ergibt Mindest-Volumen nutzbarer Luft pro Messhöhe von	144 m³/h
Maximaler Anteil pro Teilbreite außerhalb des Toleranzbereiches	30.0 %

Messfeld

	horizontal	vertikal
In Fahrtrichtung links	0 - 200 cm	30 - 500 cm
In Fahrtrichtung rechts	0 - 200 cm	30 - 500 cm

Grafik Vertikalverteilung

- Soll-Höhe Luftbegrenzung
- Maximale Arbeitshöhe
- Gemessene maximale Luftgeschwindigkeit
- Korridor von ±25.0% aus dem gemessenen mittleren nutzbaren Luftvolumen
- Mindestgeschwindigkeit nutzbare Gebläseluft (4.0 m/s)
- Gemessene Strömungsrichtung Gebläseluft

Punktgrafik Luftgeschwindigkeit

- Luftgeschwindigkeit ≥ 1.5 m/s und < 4.0 m/s
- Luftgeschwindigkeit ≥ 4.0 m/s
- Maximale Luftgeschwindigkeit auf Messhöhe ≥ 4.0 m/s

Grafik Luftvolumen Vertikalverteilung

- Gesamtes Luftvolumen bei Lüfterdrehzahl 0 U/min
- Nutzbares Luftvolumen bei Lüfterdrehzahl 0 U/min
- Potentiell nutzb. Luftvol. bei Lüfterdrehzahl 0 U/min

The AirCheck®-Fan Type Selection Aid: Result in Reality

The air stream is the means for transporting the droplets into the target structure, but must not remove them from there. **The fan is not an air force!**
All negative effects increase and all positive effects decrease with an increasing vertical angle of the air flow and increasingly excessive fan speed!

Quality of spray application is determined by a) **fan type and adjustment of the farm specific working height** (task of the manufacturer)

Canopy Adapted Spray Application: How to Use?

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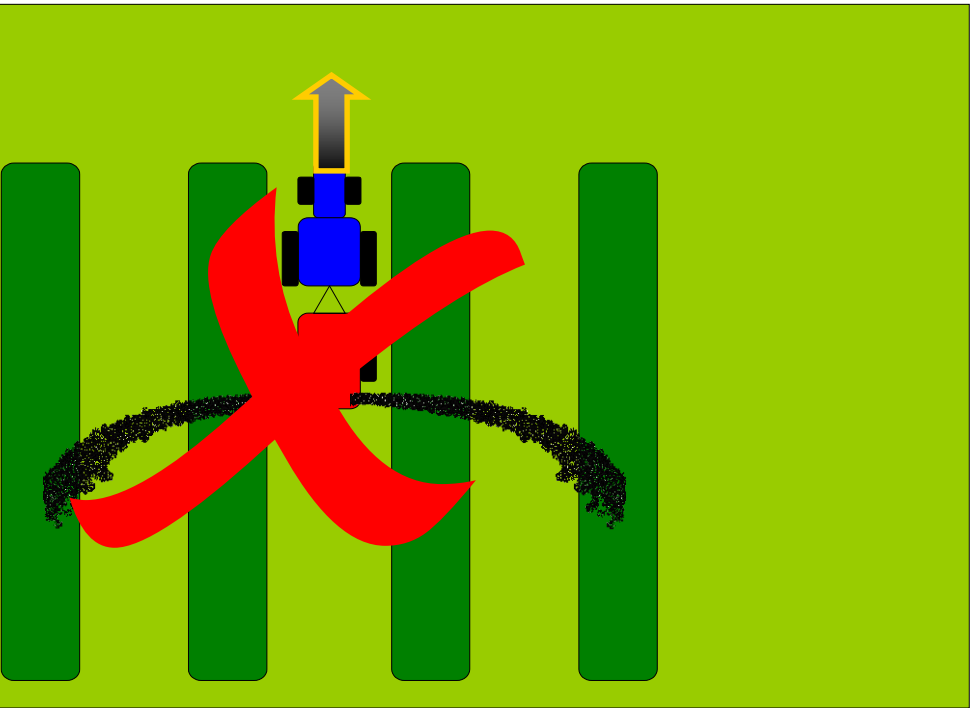
b) Forward speed and fan speed (operator and consultant)
Also forward speed and fan speed need dosing!!



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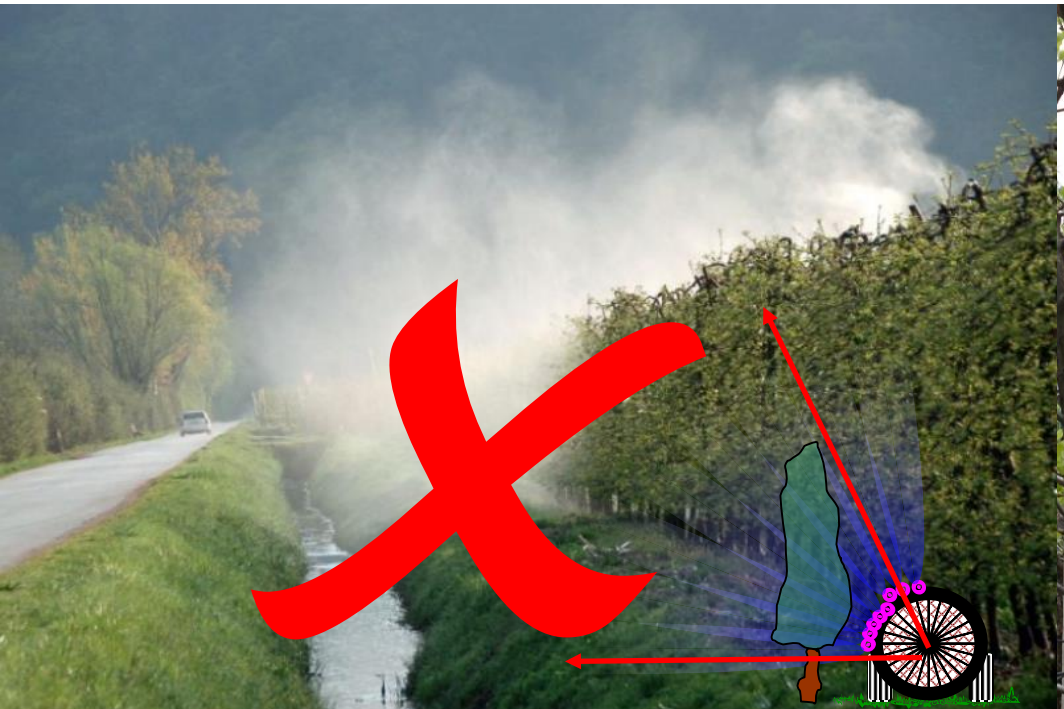

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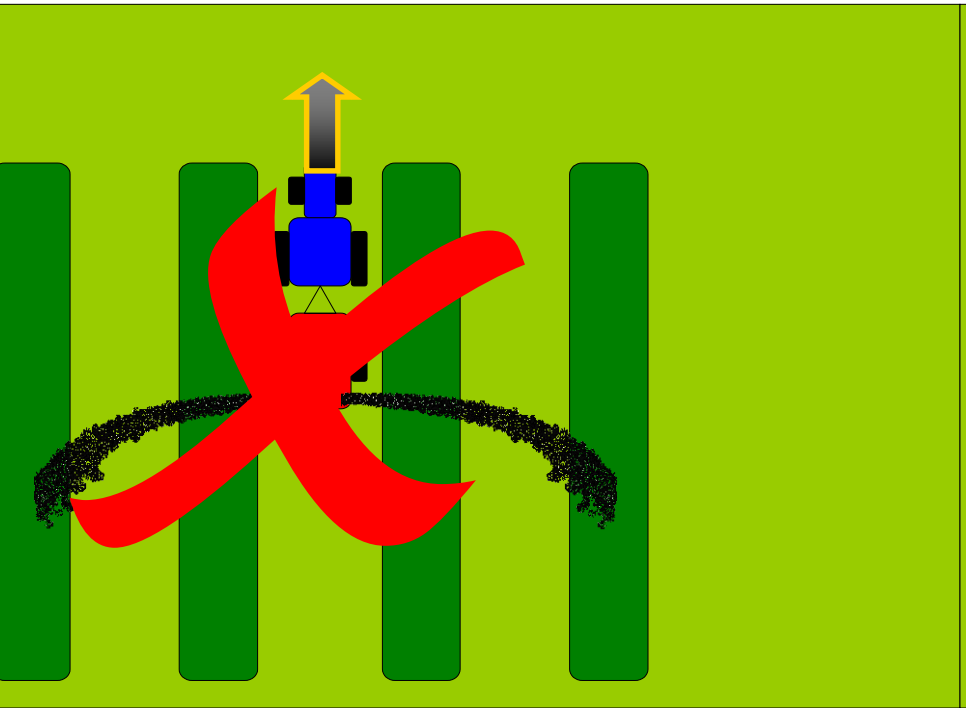

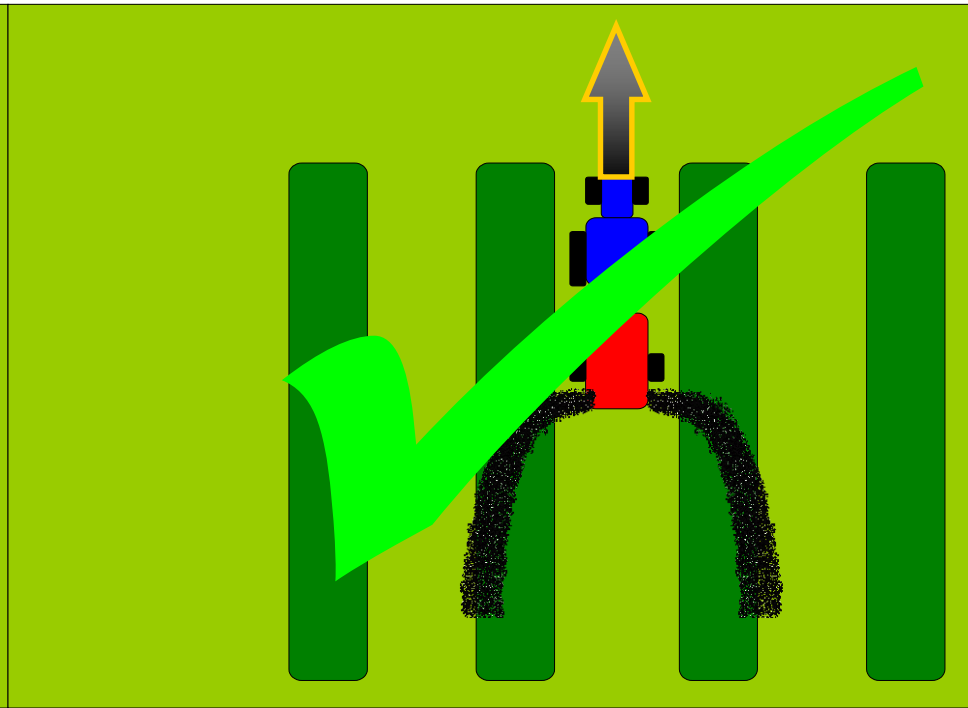

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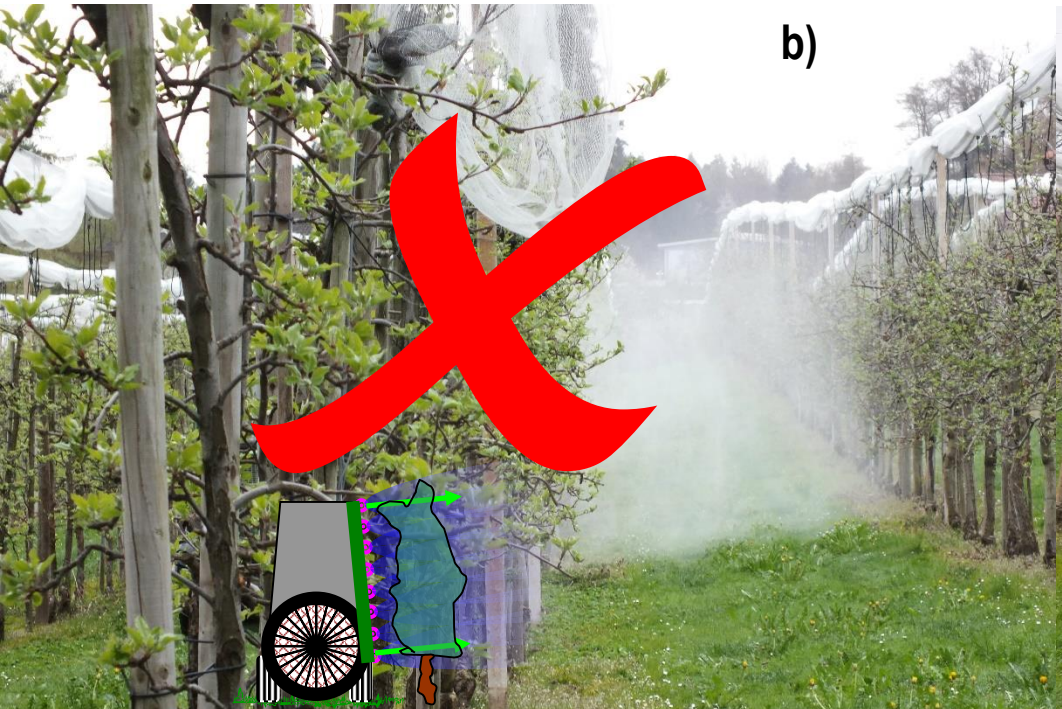
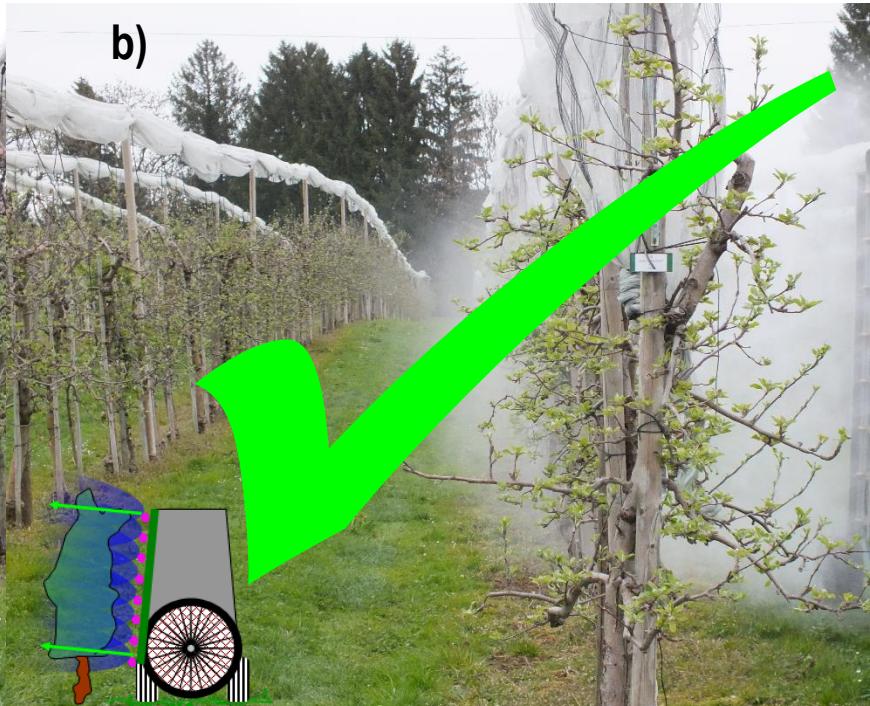




Canopy Adapted Spray Application: How to Dose and Spray?

The „AOS43“-dosing model: The rules for the same deposit with less product, less time, less fuel, less noise, less drift and less trouble

Canopy width m	Target value forward speed km h^{-1}	Guiding value fan speed* PTO min^{-1}	Relative dose rate %	Crossflow fan „Wanner ZA32“ Net time consumption min ha^{-1} at a row distance of 2,75 m	3,0 m	3,25 m	3,5 m	4,0 m	4,5 m	5,0 m
1,0	12,0	290	54 | 50	**18**	**16**					
1,25	9,7	310	63	23	**21**	19				
1,5	8,1	330	69	27	25	**23**	21			
1,75	6,9	350	81	32	29	**27**	25			
2,0	6,1	369	86		33	30	**28**	25		
2,25	5,4	388	96			33	**31**	28		
2,5	4,8	406	94				33	**31**	28	
2,75	4,4	424	92					33	**30**	
3,0	4,0	442	90						33	**30**
3,25	3,7	460	98							**32**
3,5	3,5	477	100							**33**

* = low gear

In slim canopy structures on flat land the „AOS43“-results in an enormous reduction of time consumption for spraying and increasing work rate up to 4 ha hr $^{-1}$

The Effects of the Air Support on Spray Deposit

The fan type and the adaptation of application to the target is the key to an anormous reduction of spray drift from small droplets!

What effect has the adaptation of the airflow on the deposits at the leaf?

The starting point: The AOS43 dosing model which adapts water volume, pesticide dose rate, forward speed and fan speed to the target

The result of the model:

With decreasing canopy width

water volume decreases
pesticide dose rate decreases
fan speed decreases
forward speed increases

Independant from forward speed, fan speed needs to be adapted to canopy width, avoiding significant release of spray mist into the neighbouring alley way

The Effect of the Air Support on Spray Deposit

Comparison of two methods

spray liquid volume + forward speed + fan speed adapted to canopy width
with
constant spray volume (200 l/ha) **+** *full fan speed* (540 ll) **+** *slightly varying forward speed* (7–9 km/h)

Parameters assessed:

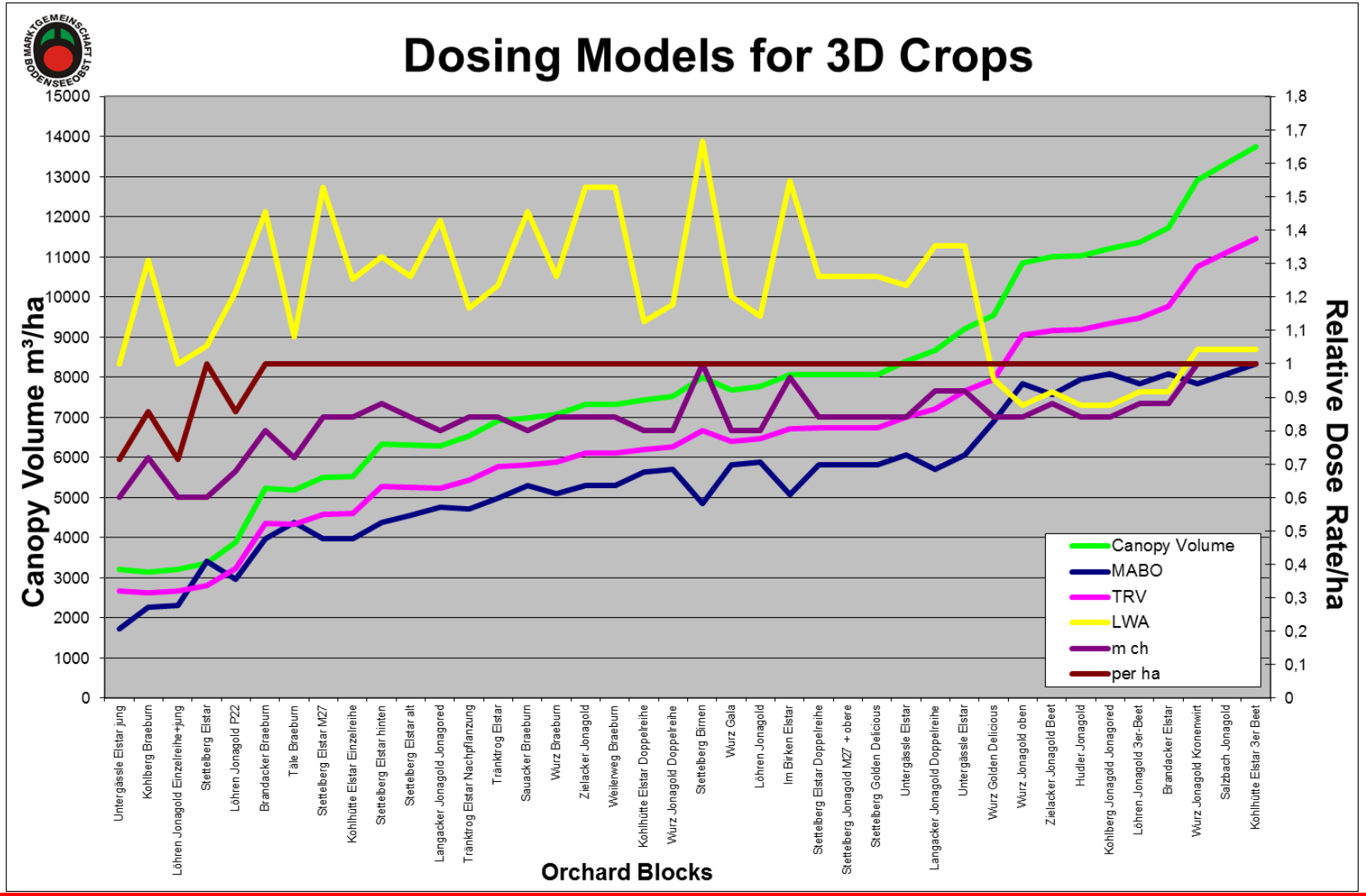
Spray deposit: µg cm^{-2} per liter of liquid sprayed
Coverage: % per liter of liquid sprayed
Droplet density: number cm^{-2} per liter of liquid sprayed

Changes of deposition efficacy		3 row bed	Slender spindle	Super spindle
Application parameters		3,9 km/h 460 l, 234 l/ha	9,0 km/h 330 l, 150 l/ha	12,1 km/h 290 l, 114 l/ha
Spray deposit	(total leaf)	+14%	+29%	+35%
Coverage	(upper leaf surface)	-29%	+26%	+67%
	(lower leaf surface)	-27%	-3%	+7%
Droplet density	(upper leaf surface)	-5%	+27%	+55%
	(lower leaf surface)	+17%	+28%	+27%

A rectangular air distribution and an adaptation of fan speed to canopy width at any forward speed,
in a slender spindle system compensates a 25% reduction of spray liquid (dose rate) ha^{-1}
in a super spindle system compensates a 35% reduction of spray liquid (dose rate) ha^{-1}

Canopy Adapted Spray Application: What About Dose Rates?

Orchards of a fruit farm at Lake Constance



Increased spray deposition efficacy and reduced pesticide use through canopy adapted spray application demands for a new dosing model. The leaf wall area model is a NO GO!

Canopy Adapted Dosing & Spray Application: Dose Rates

Typical dose rates in pome fruit (3 m canopy height)

	Registration max.	Reference dose rates for canopy adapted dosing & spray applikation	Minimum
Dithianon	0,75 kg/ha	0,5 kg/ha	0,25 - 0,35 kg/ha
Pirimicarb	0,75 kg/ha	0,5 kg/ha	0,15 - 0,3 kg/ha
Azadirachtine	4,5 l/ha	3,0 l/ha	1,5 l/ha
Captan	1,8 kg/ha	1,2 kg/ha	1,2 kg/ha
Penconazole	0,375 kg/ha	0,25 kg/ha	0,15 - 0,25 kg/ha
Dodine	1,875 l/ha	1,25 l/ha	1,0 l/ha
Thiacloprid	0,3 kg/ha	0,2 kg/ha	0,15 kg/ha
Flonicamid	0,21 kg/ha	0,12 kg/ha	0,12 kg/ha
Chlorantraniliprole	0,263 kg/ha	0,175 kg/ha	0,15 kg/ha
Trifloxystrobin	0,15 kg/ha	0,1 kg/ha	0,08 kg/ha
Copper hydroxid	1,5 l/ha	1,0 l/ha	0,25 - 1,0 l/ha

Comparing Official with Target-Adapted Spray Application

The trial (2020 - 22)

Participants: max 7 professional fruit farms; 5 x IP, 2 x organic, with three plots

1. **Untreated**
2. **Classical** dosing: per ha mch, forward speed 6-8 km h^{-1}, fan speed ~450 PTO min^{-1} II, ISO air induction nozzles 01, approx. 300 l/ha
   - Reference for dosing: real canopy height m ch
3. **AOS43** dosing: (forward speed, fan speed, water volume ha^{-1} and dose rate ha^{-1} adapted to canopy width and canopy height independently from each other; nozzle: ATR purple + 2x2 ISO air induction nozzles 01, 120-180 l ha^{-1}
   - Reference = max. dose rate = registered dose rate for 2 m ch;
     mimimum dose rate = 1 m ch
     Efficiency gains of deposition: broad canopies +15%, slim canopies + 40%

Treatments after MABO advisory service from bud burst until the end of apple scab primary season. Secondary season with farm specific spray schedule

Assessments

- after all primary infections have finished incubation period
- 200 shoots per plot:
- number of infected shoots
- number of infected leaves per shoot
- number of leaves with sheetscab per shoot
- number of scab lesions per leaf
- number of fruits wth fruit scab on 200 fruits per plot

Comparing Official with Target-Adapted Spray Application

The results: Number of leasons on 200 shoots

Apologies for not showing the graphs of the results here,
since they´re not yet published.

The scab attack in the untreated blocks show a clear correlation to the general scab attack of the year.
Comparison of the two systems: In 75% of the trials AOS shows the same or better results than “Classical“.
In 12,5% of the trials AOS is less than 10% and in 12,5% more than 10% worse compared to „Classical“.

Comparing Official with Target-Adapted Spray Application

Changes in consumption of fungicides

Apologies for not showing the graphs of the results here,
since they´re not yet published.

The result: In orchards with slim canopy systems (slender spindle, super spindle) and canopy heights of 2,0 – 2,3 m „AOS“ on average consumed 55% less product per ha and treatment compared to „Official“; compared to 3,0 m canopy height approx 64% less.

Target-adapted Spray application: How Much Spray Drift?

Spray Drift Reduction with Small Droplets

- **Fans with cross flow characteristics at any forward speed**
  + canopy adapted fan speed
  + mixed nozzle set (ATR purple + 2 x 2 AVI 80-01 / IDK 90-01)
  - **reduce spray drift by >80%*** (officially registered in the 75% drift reduction class, 90% in progress)
  + hail net
  - **reduce spray drift by >90%***

- **Fans with cross flow characteristics at any forward speed**
  + air flow control
  + active deflection air stream
  + canopy adapted fan speed
  + full hollow cone nozzle set (ATR purple)
  - **reduce spray drift by ~95%***

*= Compared to german spray drift reference values

„Canopy Adapted“ vs. „Classical“: A Potential Study

Results for fruit farms in Hardanger

	Farm / Orchard / Area # 1			Farm / Orchard / Area # 2		
Acreage (net-value)	305	ha		305	ha	
Number of farms/orchards	220	Average farm size 1,39 ha		220		
Average yield	20	t/ha		20	t/ha	
Row distance	3,5	m		3,5	m	
Canopy width	1,2	m		1,2	m	

Currency:	NOK	Dosing per ha, mch,TRV	Dosing model AOS43		
AOS43 reference values			# of main nozzles (Type I) available on sprayer	12	The sprayer is equipped with totally 2 x 8 nozzles!
6667	$m^2 ha^{-1}$ max. filter layer area		# of low drift nozzles (Type II) available on sprayer	4	
33	$min\ ha^{-1}$ max. net spraying time		Spray liquid pressure	7,5	bar Type in desired spray liquid pressure
					Nozzle type I
			Number of open main nozzles type I:	12	Albuz ATR purple
			Flow rate nozzle type I at 7,5 bar (l/min):	0,43	←↑Type in from manufacturer data
				1	Nozzle type II
			Number of open low drift nozzles type II:	4	Lechler IDK 90-01 C
			Flow rate nozzle type II at 7,5 bar (l/min):	0,63	←↑Type in from manufacturer data

Number of spray runs per year (reference)	15					
Number of spray runs per year	15	/a		15	/a	
Consumption sprayable pesticides (without herbicides)	20.000	NOK/ha*a	20.000	20.000	NOK/ha*a	
Costs water	31,30	NOK/m³		31,30	NOK/m³	
Costs crop protection machinery (tractor + sprayer)	600,00	NOK/h		600,00	NOK/h	
Cost crop protection labour	175,00	NOK/h		175	€/h	
Vat content	1.000	l		1.000	l	
Water volume	300	l/ha		130	l/ha	
Surplus capacity last vat per spray trip	58	%		82	%	
Travelling distance on roads vat filling	1,0	km		1,0	km	
Travelling speed on roads vat filling	20,0	km/h AV		20,0	km/h AV	
Diesel consumption/100 km tractor travelling on roads	30,0	l/100 km		30,0	l/100 km	
Net time consumption vat filling	0,5	h/vat filling		0,5	h/vat filling	
Forward speed spray application in the orchard	5,0	km/h		10,1	km/h	
Net time consumption spray application per ha	34,3	min/ha		17,0	min/ha	
Diesel consumption tractor driving for spray application	18,0	l/100 km at 5 km/h	22,0	22	l/100 km at 10,1 km/h	
Fan speed (PTO)	480	U/min		330	PTO	
Diesel consumption sprayer — Most ineffcient fan type	7,51	l/h	Efficient fan type	0,70	l/h	
Specific CO_2-emissions Diesel	2,65	kg/Liter		2,65	kg/Liter	
Costs Diesel	14,55	NOK/l		14,55	€/l	
Time consumption sprayer cleaning	45	minutes/trip (traditional)		10	minutes/trip (automatic)	
Water for sprayer cleaning (10% of vat content)	100	l		100	l	

„Canopy Adapted“ vs. „Standard“: A Potential Study

Results for fruit farms in Hardanger (Effects of only the spray application)

Crop protection total per year (only orchard sprayer; no herbicides)			Changes orchard/farm/area # 2 versus # 1	
Number of vat fillings per treatment	220	220	0,00	0,0 %
Surplus capacity last vat per treatment	--- %	--- %		
Number of vat fillings per year	3.300 /a	3.300 /a	0,00 /a	0,0 %
Time consumption vat fillings (travelling and filling)	1.815,00 h/a	1.815,00 h/a	0,00 h/a	0,0 %
Time consumption treatments	2.614,29 h/a	1.294,01 h/a	-1.320,28 h/a	-50,5 %
Time consumption vat cleaning	2.475,00 h/a	550,00 h/a	-1.925,00 h/a	-77,8 %
Ratio auxiliary process time to total time consumption	62,14 %	64,64 %	-1.925,00 h/a	-44,9 %
Total travelling distance spray application	16.371,43 km/a	16.371,43 km/a	0,00 km/a	0,0 %
Diesel consumption of sprayer	22.980,26 l/a	4.773,19 l/a	-18.207,07 l/a	-79,2 %
CO_2-emissions from Diesel	60.897,68 kg/a	12.648,95 kg/a	-48.248,73 kg/a	-79,2 %
Costs Diesel	334.362,75 NOK/a	69.449,92 NOK/a	-264.912,83 NOK/a	-79,2 %
Water consumption	1.374,00 m³/a	597,78 m³/a	-776,22 m³/a	-56,5 %
Costs water	43.006,20 NOK/a	18.710,46 NOK/a	-24.295,74 NOK/a	-56,5 %
Labour consumption crop protection	6.904,29 h/a	3.659,01 h/a	-3.245,28 h/a	-47,0 %
Labour costs	1.208.250,00 NOK/a	640.326,18 NOK/a	-567.923,82 NOK/a	-47,0 %
Machinery costs	4.142.571,43 NOK/a	2.195.404,04 NOK/a	-1.947.167,39 NOK/a	-47,0 %
Costs pesticides	6.100.000,00 NOK/a	6.100.000,00 NOK/a	0,00 NOK/a	0,0 %
Total costs crop protection	11.828.190 NOK/a	9.023.891 NOK/a	-2.804.300 NOK/a	-24 %
Total costs crop protection per ha and year	38.781 NOK/ha*a	29.587 NOK/ha*a	-9.194 NOK/ha*a	-24 %
Total costs crop protection per 100 kg	193,90 NOK/100 kg	147,93 NOK/100 kg	-45,97 NOK/100 kg	-24 %

Labour effects: forward speed + 1 km h^{-1} = -291 h/a; water volume -100 l ha^{-1} = 0 h/a; vat capacity + 500 l = 0 h/a; automatic vat cleaning = -1.283 h/a

Cost effects: forward speed + 1 km h^{-1} = -256.866 NOK; water volume -100 l ha^{-1} = -9.547 NOK; fan speed -100 PTO = -90.585 NOK; automatic vat cleaning = -994.583 NOK

„Canopy Adapted“ vs. „Standard“: A Potential Study

Results for fruit farms in Hardanger (Effects of both, canopy adapted application and AOS43 dosing*)

Crop protection total per year (only orchard sprayer; no herbicides)			Changes orchard/farm/area # 2 versus # 1	
Number of vat fillings per treatment	220	220	0,00	0,0 %
Surplus capacity last vat per treatment	--- %	--- %		
Number of vat fillings per year	3.300 /a	3.300 /a	0,00 /a	0,0 %
Time consumption vat fillings (travelling and filling)	1.815,00 h/a	1.815,00 h/a	0,00 h/a	0,0 %
Time consumption treatments	2.614,29 h/a	1.294,01 h/a	-1.320,28 h/a	-50,5 %
Time consumption vat cleaning	2.475,00 h/a	550,00 h/a	-1.925,00 h/a	-77,8 %
Ratio auxiliary process time to total time consumption	62,14 %	64,64 %	-1.925,00 h/a	-44,9 %
Total travelling distance spray application	16.371,43 km/a	16.371,43 km/a	0,00 km/a	0,0 %
Diesel consumption of sprayer	22.980,26 l/a	4.773,19 l/a	-18.207,07 l/a	-79,2 %
CO_2-emissions from Diesel	60.897,68 kg/a	12.648,95 kg/a	-48.248,73 kg/a	-79,2 %
Costs Diesel	334.362,75 NOK/a	69.449,92 NOK/a	-264.912,83 NOK/a	-79,2 %
Water consumption	1.374,00 m³/a	597,78 m³/a	-776,22 m³/a	-56,5 %
Costs water	43.006,20 NOK/a	18.710,46 NOK/a	-24.295,74 NOK/a	-56,5 %
Labour consumption crop protection	6.904,29 h/a	3.659,01 h/a	-3.245,28 h/a	-47,0 %
Labour costs	1.208.250,00 NOK/a	640.326,18 NOK/a	-567.923,82 NOK/a	-47,0 %
Machinery costs	4.142.571,43 NOK/a	2.195.404,04 NOK/a	-1.947.167,39 NOK/a	-47,0 %
Costs pesticides	6.100.000,00 NOK/a	3.501.751,82 NOK/a	-2.598.248,18 NOK/a	-42,6 %
Total costs crop protection	**11.828.190 NOK/a**	**6.425.642 NOK/a**	**-5.402.548 NOK/a**	**-46 %**
Total costs crop protection per ha and year	**38.781 NOK/ha*a**	**21.068 NOK/ha*a**	**-17.713 NOK/ha*a**	**-46 %**
Total costs crop protection per 100 kg	**193,90 NOK/100 kg**	**105,34 NOK/100 kg**	**-88,57 NOK/100 kg**	**-46 %**

*The costs of pesticides is ment only as synonym für the amount of pesticides used!

Canopy Adapted Dosing & Spray Application: What is needed?

1. **Cross flow fan types with a low angle of the air flow (general AirCheck®-certification)**
   a) Spray deposition is improved by fan design
   b) Spray drift is allready reduced by fan design
   c) AirCheck®-certification guaranties suitability for canopy adapted spray application

2. **Farm specific adjustment of the air and liquid distributions on air and liquid vertical distribution test benches (individual AirCheck®-certification)**
   Enables spray application at canopy width adapted fan speed and forward speed of the individual fan

3. **Hollow cone nozzles (ATR purple) for high quality spray cover**
   a) Enables control of the horizontal reach of the droplets by the air stream and forward speed
   b) Increases spray deposition efficacy up to 40%

4. **2 x 2 „01“- ISO anti drift nozzles at the two top most nozzle positions + canopy adapted fan speed**
   Potentially reduces spray drift by > 90% at low water volumes; four fan types officially registered in 75% drift reduction class

5. **A model for dosing and spray application in 3D crops**
   The AOS43 dosing adapts 4 parameters (dose rate, water volume, forward speed, fan speed) to the 3 dimensions of 3D-crops.

6. **Training of operators**
   a) Theoretical and practical training
   b) Ev. correction of the tree height

7. **Cooperation with sprayer manufacturers**
   a) Annual technical workshop
   b) Participation in the AirCheck®-Initiative

Canopy Adapted Dosing and Spray Application: The Benefits

1.) Allows a significant reduction of pesticide dose rates and their negative side effects
   by improved and adjusted air distribution, a mixed nozzle set, canopy adapted dosing and spray application

2.) Increases work rate significantly
   by low water volumes (more ha per vat filling), canopy adapted spray application, improved sprayer cleaning

3.) Reduces risk for contamination of the operator
   by low water volumes (less vat fillings per spray trip)

4.) Reduces relative spray drift
   by mixed nozzle set, improved and adjusted air distribution, canopy adapted spray application

5.) Reduces absolute spray drift
   by mixed nozzle set, improved and adjusted air distribution, canopy adapted dosing and spray application

6.) Reduces fuel consumption
   by low water volume, energy efficient fans, improved and adjusted air distribution, canopy adapted spray application

7.) Reduces noise emission
   by silent fan types, improved and adjusted air distribution, canopy adapted spray application

8.) Reduces conflicts with bystanders
   by silent fan types, improved and adjusted air distribution, canopy adapted spray application, reduced dose rates

9.) Reduces labour and costs
   by low water volumes, improved and adjusted air distribution, canopy adapted spray application, reduced dose rates

Canopy Adapted Dosing and Spray Application: The Benefits

1.) Allows a reduction of pesticide dose rates (reference ~-33% + canopy adapted < ~-35%)
by improved and adjusted air distribution, a mixed nozzle set, canopy adapted dosing and spray application

2.) Increases work rate significantly (potential ≤ ~38%)
by low water volumes (more ha per vat filling), canopy adapted spray application, improved sprayer cleaning

3.) Reduces risk for contamination of the operator (potential ≤ ~33%)
by low water volumes (less vat fillings per spray trip)

4.) Reduces relative spray drift > 80% (75% registered, 90% in progress, potential > 95%)
by mixed nozzle set, improved and adjusted air distribution, canopy adapted spray application

5.) Reduces absolute spray drift > 90% (potential ≤ ~97%)
by mixed nozzle set, improved and adjusted air distribution, canopy adapted dosing and spray application

6.) Reduces fuel consumption ≤ ~80% (potential ≤ ~97%)
by low water volume, energy efficient fans, improved and adjusted air distribution, canopy adapted spray application

7.) Reduces noise emission ≤ ~80% (potential ≤ ~99,8%)
by silent fan types, improved and adjusted air distribution, canopy adapted spray application

8.) Reduces conflicts with bystanders (invaluable asset)
by silent fan types, improved and adjusted air distribution, canopy adapted spray application, reduced dose rates

9.) Reduces labour and costs (potential ≤ ~40%)
by low water volumes, improved and adjusted air distribution, canopy adapted spray application, reduced dose rates

AOS (AirCheck®-Optimized Spraying) in 3D-Crops

is the combination of reducing pesticide use and spray drift

Offers enormous potentials:

Approx. 50% reduction of pesticide consumption in 3D crops
May maintain availability of registered and favour registration of new pesticides
Less spray drift
Less noise
Less time
Less fuel
Lower costs
Less hassle

Has requirements:

Low angle cross flow fans with individually adjusted air & liquid distribution
An app to calculate spray application parameters
Crop height incl. shoots at the top max. 3,5 m at 3,0 m row distance
Correct use for good results

Must not be abused!

AOS and politics:

The „Green Deal“ of the EU: Reduction of pesticide use by 50% in 2030

Fruit growing is ready!

Thank You very much for Your attention!

Canopy Adapted Dosing and Spray Application in 3D Crops

Make Use of the Potentials

Dr. Peter Triloff
Marktgemeinschaft Bodenseeobst eG
Friedrichshafen

AirCheck® Optimierung Luftverteilung für Sprühgeräte in Raumkulturen für Umweltschutz im Pflanzenschutz www.aircheck.eu

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