Protection by ordinary light clothing against pesticide spray drift for bystanders and residents

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Occupational and Bystander Exposure Technical SubGroup
(CLE OBE TSG)

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Background on bystander/resident exposure

- 4 exposure scenarios (spray drift, vapour, surface deposits, entry into treated crop)
  - dermal exposure to direct spray drift is predominant
- No PPE; ordinary (i.e., “light” or “minimal”) clothing can provide a certain level of protection
- EFSA GD assumes minimal clothing
  - Covered body (trunk) 36% × protection 50% = exposure reduction 18%
  - Exposure reduction 18% → adjustment factor (AF) 0.82 used in spray drift exposure calculation

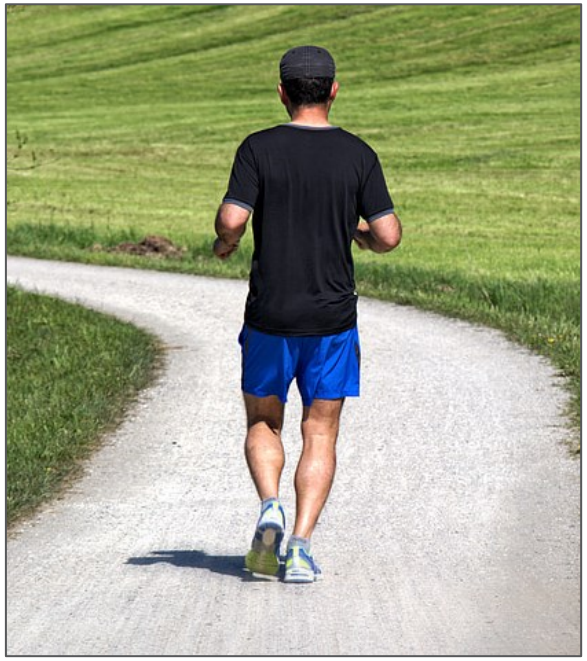
  - Assumed penetration 50% (EUROPOEM,1996) but data showed penetration mostly 2–20%
  - 50% penetration – preliminary estimation derived from operator exposure data
    - Bystander exposure – very brief exposure to spray drift
    - Operator exposure – splashes, spray drift over the workday and contact with contaminated surfaces

Background on bystander/resident exposure

- The AF for ordinary clothing has been derived from operator exposure data
- Operator normal workwear
  - coveralls or long-sleeved jackets/shirts and trousers that cover arms, body and legs
  - made of dense weave cotton or cotton/polyester material
- Bystander/resident ordinary clothing
  - clothes that partially cover arms and legs, i.e., t-shirts and shorts
- More appropriate to consider exposure-scenario relevant data

Operator clothing

AOEM studies



Bystander clothing

https://www.pickpik.com/jogger-hobby-leisure-sport-run-movement-145097

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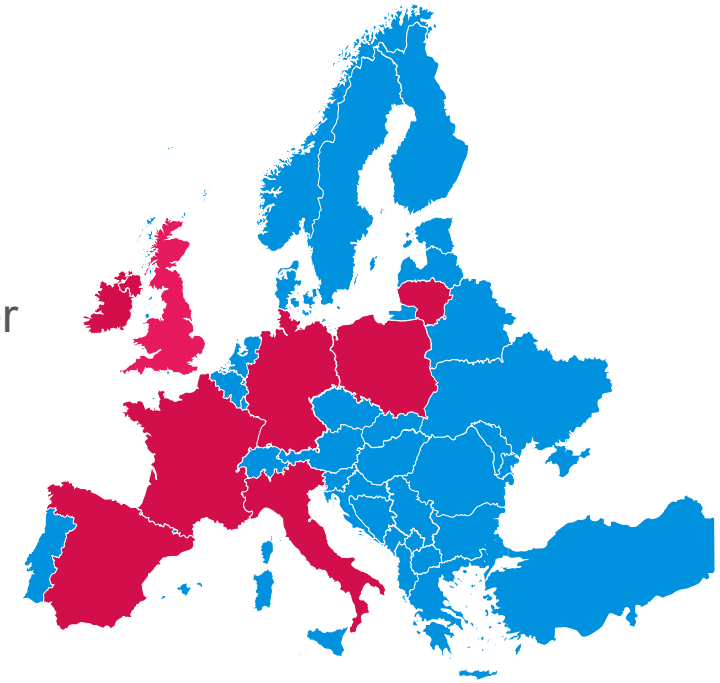
Locations, application details, environmental conditions

- 32 GLP studies with 9 different active ingredients (AI)
- Conducted by CLE members between 2011 and 2019
- Locations: DE, FR, IE, IT, LT, PL, ES, UK
- Crops: pome fruit, vineyard, oilseed rape, pre-emergence, spring/winter barley, sugar beet, winter wheat
- BBCH stages: 00-65 low crops, 53-91 pome fruit, 13-81 vineyard
- Application methods: tractor broadcast air-assisted, boom sprayer
- Formulation types: CS, EC, OD, SC, SL, WG
- Water volumes: 99-1091 L/ha
- Spray pressure: 1.3-22.5 bar
- Nozzles: normal and drift-reducing, Nr 4-72
- Driving speed: 1.47-12.6 km/h
- Distance from zero line: 2-15 m

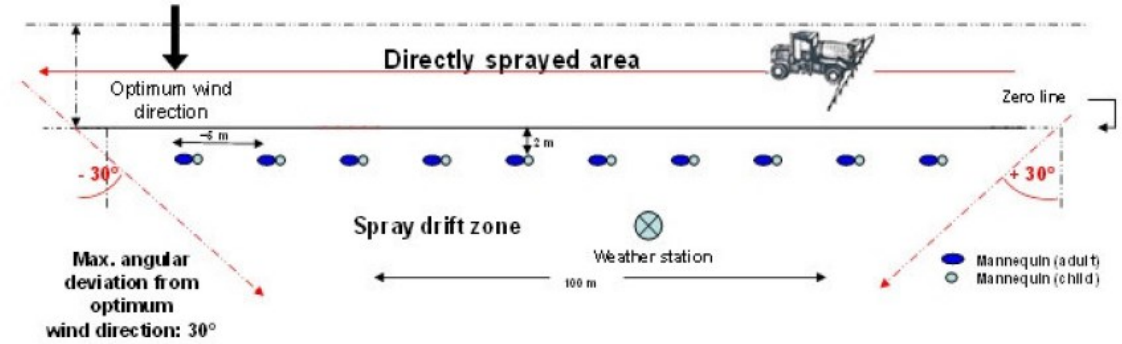


- Average wind speed: 0.3-4.4 m/s
- Average temperature: 2.2-32.2°C
- Relative humidity: 32.3-96.6%

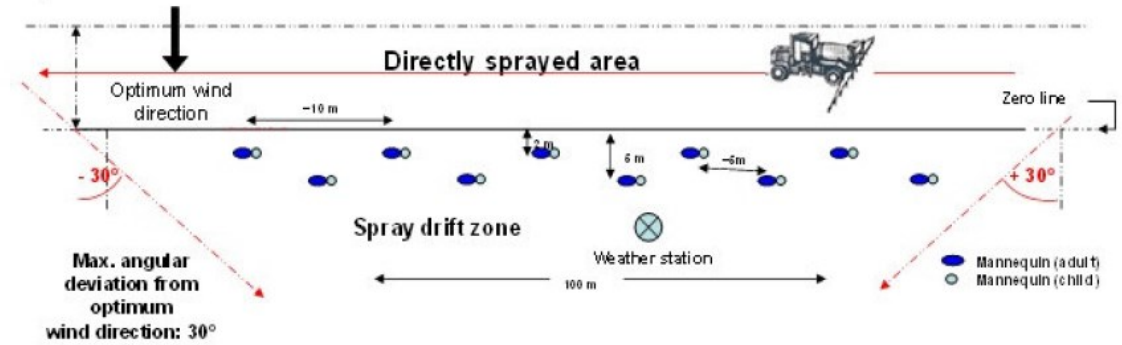
Sampling setup

- A total of 742 replicates over all studies, equal numbers of adult and child mannequins
- Body height: adult ~ 1.88 m, child ~ 1 m
- 16-54 replicates for each trial
- Mannequins at various distances downwind from the zero-metre position
  - High crops: 5, 10, 15 m
  - Low crops: 2, 3, 5, 8, 10, 13 m
- When multiple rows of mannequins, to avoid interference of the drift, the mannequins in each next row were off-set by 1 m

A1)



A2)



B1)

B2)

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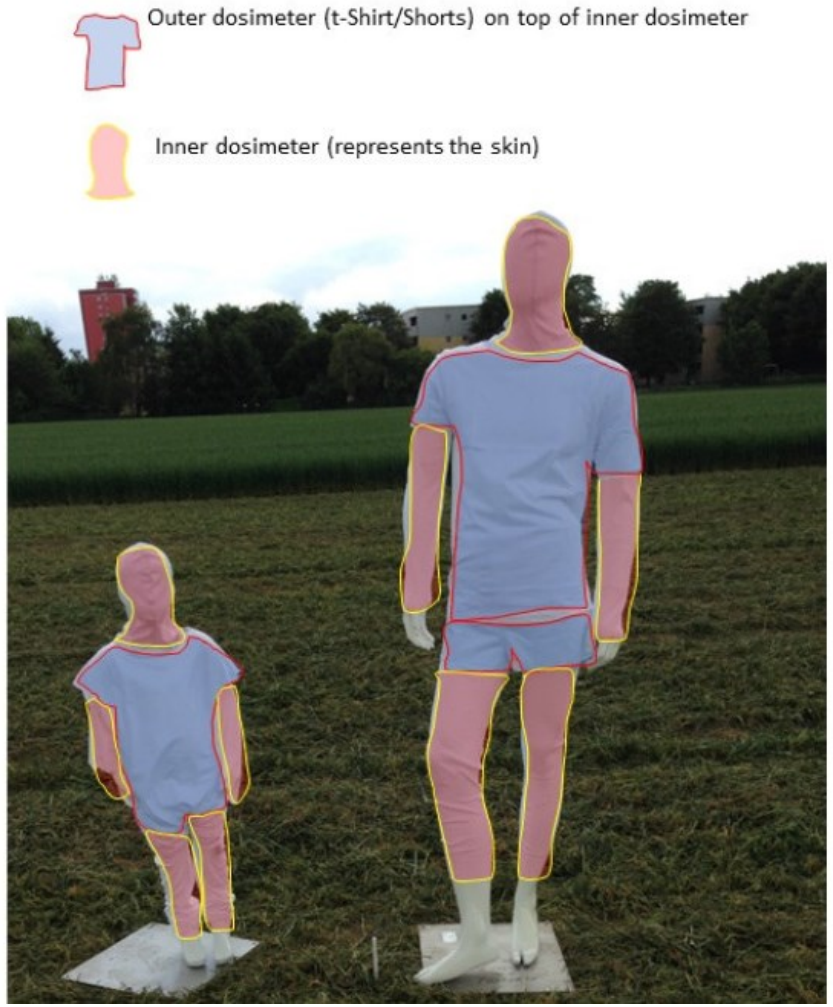
Dosimeters and measurements

- Dermal exposure determined using whole body dosimetry acc. to OECD Test Guideline No. 9 (1997) and OPPTS 875.1100 (1997)
- Inner dosimeters: full-length underwear garments (long-sleeved vest and long johns) and a head sleeve
- Outer dosimeters: 100% cotton t-shirts/shorts and 100% t-shirt and 65% polyester/35% cotton shorts
- Outer dosimeters
  - Adult – Covering torso, half of upper arms, half of thighs;
  - Child – Covering torso, half or complete upper arms, half or complete thighs
- The potential and actual dermal exposures on mannequins were measured as “mg AI/person”, then converted to “mL spray/person” by considering the concentration of the in-use spray dilution, i.e., mg AI/mL

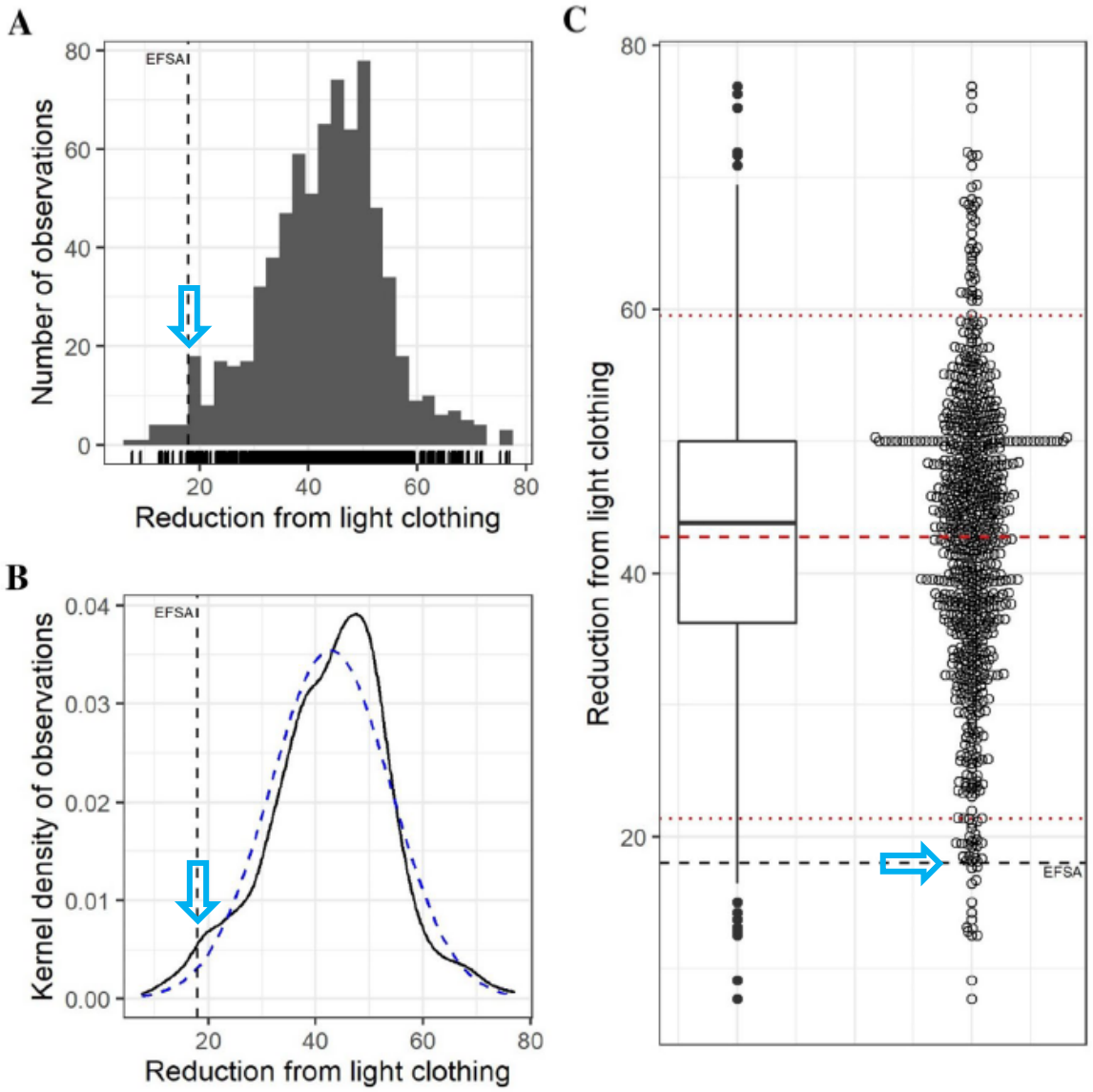


Child, ~1 m

Adult, ~1.88 m

Overview of all data

- The distribution of all values in the dataset
- 742 replicates for adult and child mannequins
- The % of reduction of exposure by light clothing ("%reduction") is greater than the EFSA value of 18% in most studies (black dashed line ---)
  - mean 42.7%; median 43.8%
- Red dashed line --- the overall mean
- Red dotted lines ··· 5th and 95th percentiles
- The spike at 50% in the beeswarm plot, showing individual values, was driven by LOQs in one study



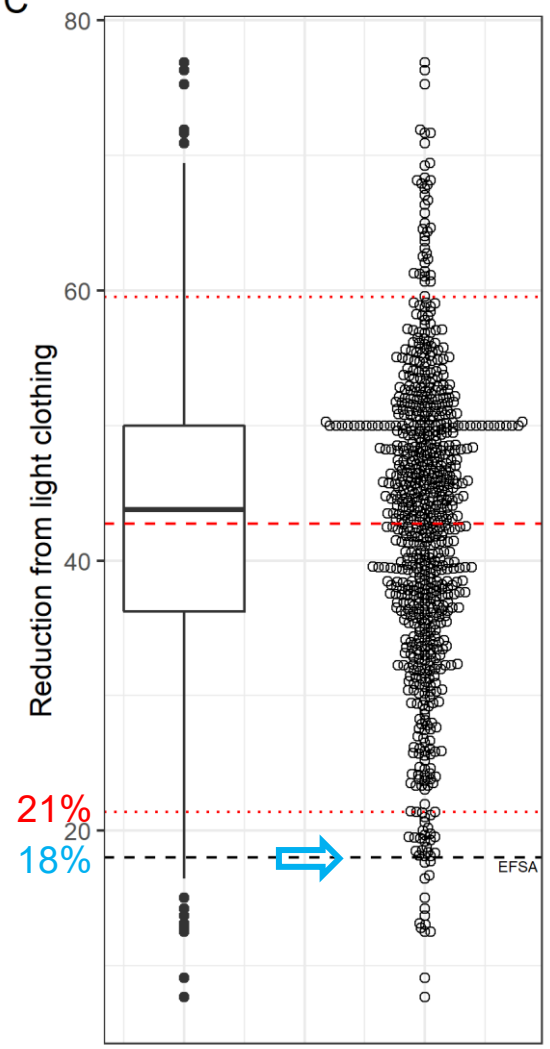
Summary statistics

- %Reduction in EFSA Guidance 18%, <5th percentile of distribution of all data

Table 2 Summary statistics for the exposure reduction factors from ordinary light clothing – including all nozzles (standard and drift-reducing)

Statistic	Reduction (%)														
	All crops	High crops, all	Low crops, all	High crops, early stage, all	High crops, late stage, all	Vineyard, early stage	Vineyard, late stage	Pome fruit, early stage	Pome fruit, late stage	Pome fruit, all	Vineyard, all	Low crops, standard nozzles, all	Low crops, drift-reducing nozzles, all	All crops, excluding vineyard	All crops, excluding vineyard early stage
n	742	306	436	144	162	72	90	72	72	144	162	344	92	580	670
Mean	42.72	42.01	43.21	35.82	47.51	27.34	44.75	44.30	50.96	47.63	37.01	43.93	40.52	44.31	44.37
SD	11.26	12.03	10.68	11.56	9.53	7.74	8.26	7.94	9.93	9.56	11.81	9.04	15.08	10.58	10.29
Min	7.64	7.64	9.09	7.64	29.91	7.64	29.91	23.80	31.80	23.80	7.64	18.76	9.09	9.09	9.09
5th	21.39	20.17	23.60	18.19	34.10	17.16	32.64	33.21	37.10	35.19	18.35	29.42	13.97	25.85	26.57
10th	27.53	24.58	29.50	19.86	36.31	18.18	35.02	36.55	40.24	37.46	20.67	32.24	19.33	31.60	32.04
25th	36.21	35.38	36.65	26.63	40.51	21.29	38.11	39.56	44.44	42.38	28.26	37.59	28.10	37.99	38.03
Median	43.79	42.70	44.67	36.87	46.13	26.89	43.88	43.85	49.00	45.97	37.15	44.85	43.34	45.21	44.97
75th	50.00	48.71	50.00	43.96	52.62	33.46	50.94	47.23	55.10	51.75	44.82	50.15	50.00	50.23	50.26
90th	55.35	56.35	54.98	48.30	61.27	37.44	56.86	51.89	66.81	62.30	52.56	54.76	55.54	55.56	55.69
95th	59.53	62.25	58.12	51.88	64.63	38.87	58.95	55.47	69.34	68.15	56.87	57.39	62.50	61.15	61.10
Max	76.90	76.90	76.30	76.90	75.27	45.40	62.33	76.90	75.27	76.90	62.33	67.92	76.30	76.90	76.90

C



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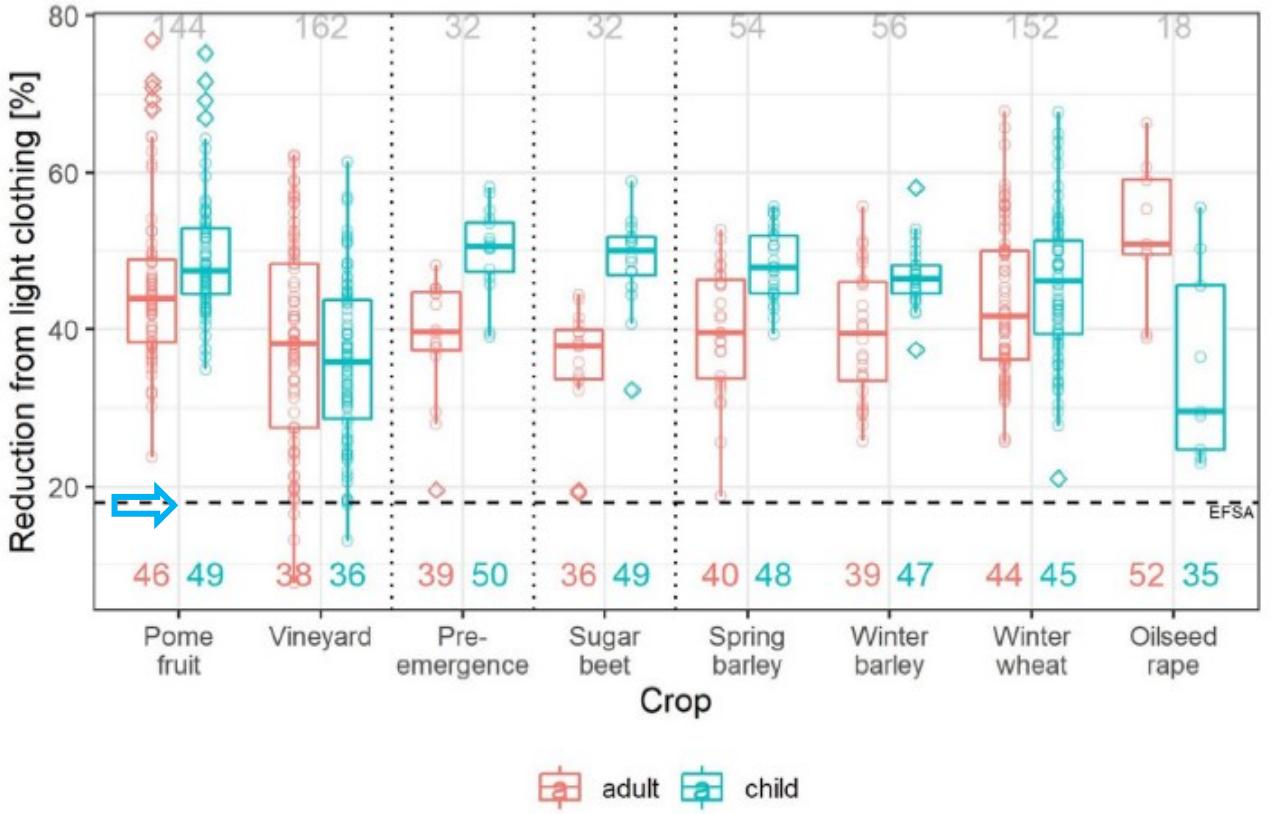
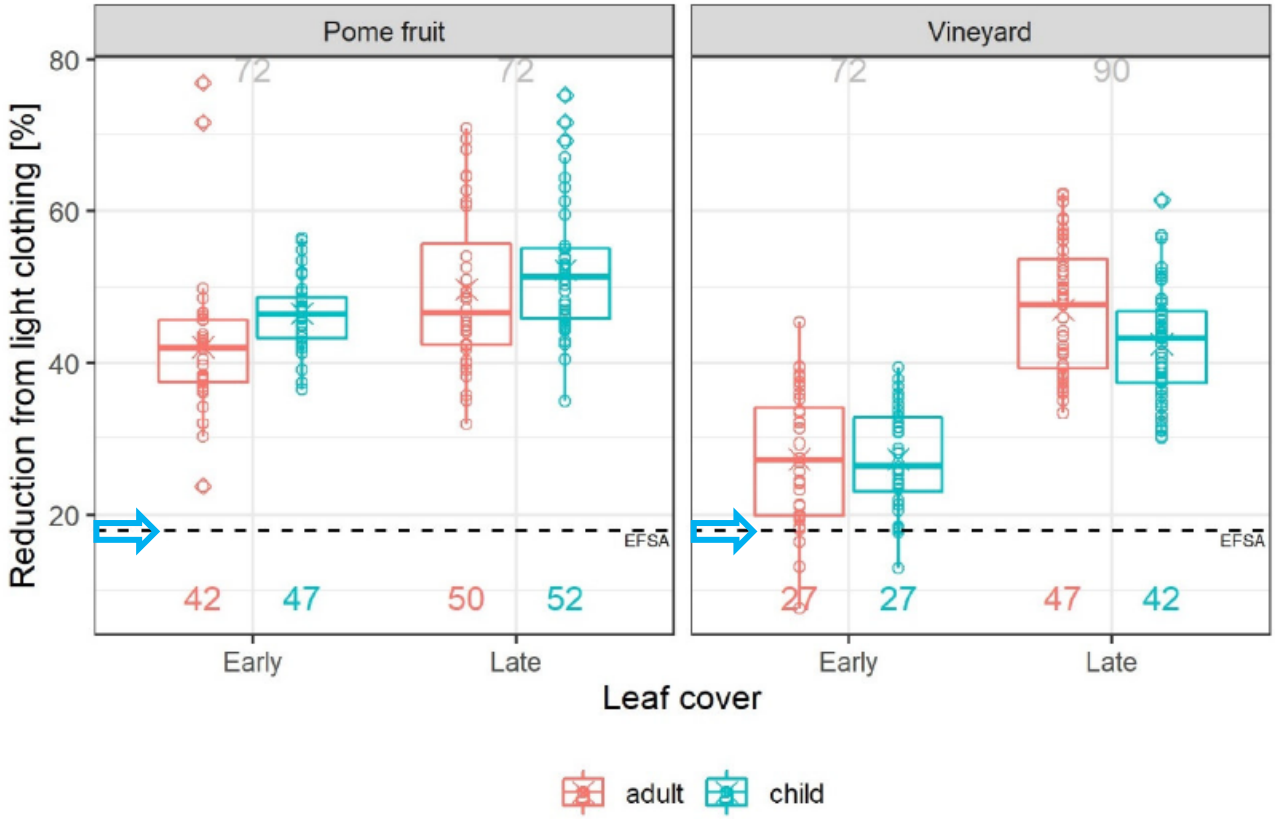
Impact of crop type

- The %reduction for adult and child mannequins according to the crop type
- The %reduction was generally higher for child than in adult mannequins
- The exceptions: vineyard and oilseed rape (no clear explanation found)
- The mean exposure %reduction for high crops is 42.01% and for low crops 43.21%



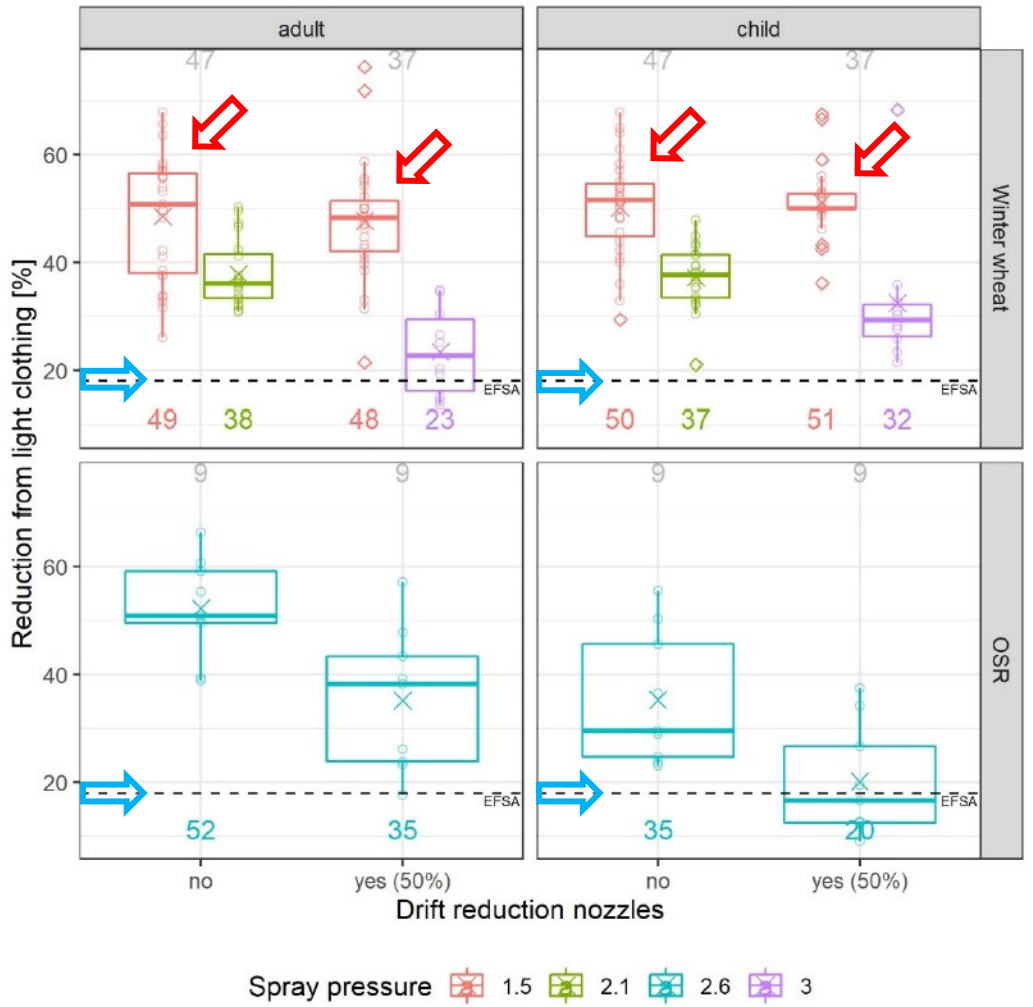
Impact of leaf cover

- The impact of the leaf cover (early vs late-stage application in high crops) on the %reduction
- For both crop types, the larger leaf cover is linked to a higher %reduction
- %reduction in early vs late-stage high crops
  - Pome fruit
    - 42 vs 50% for adults
    - 47 vs 52% for children
  - Vineyard
    - 27 vs 47% for adults
    - 27 vs 42% for children



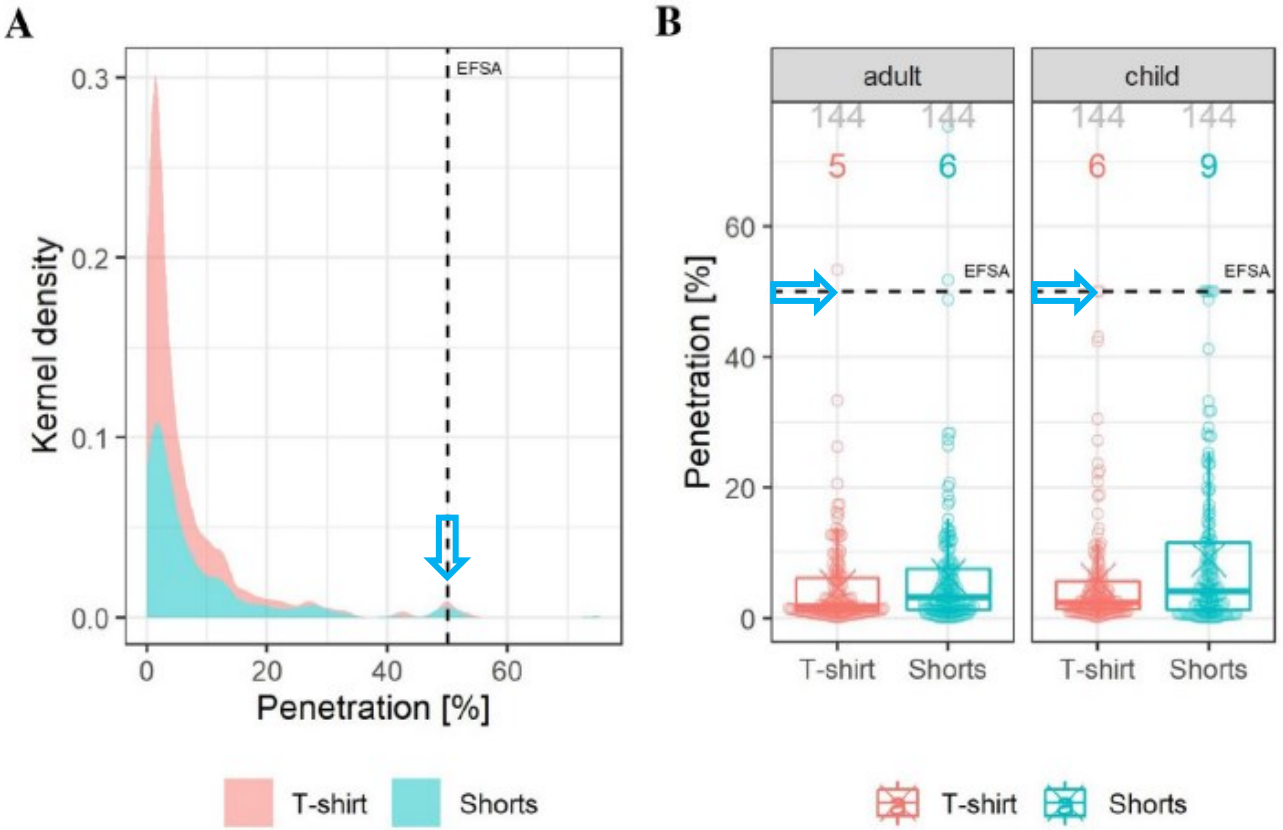
Impact of drift-reducing nozzles, spray pressure

- The effect of DR nozzles and the spray pressure on the %reduction in oilseed rape and winter wheat
- DR nozzles decrease the %reduction for adult and child mannequins
- The effect may be confounded by spray pressure
- When compared at the same spray pressure (red bars), there is little impact of the DR nozzles on the reduction % in winter wheat
- The mean exposure %reduction for low crop standard nozzles is 43.93% and for DR nozzles 40.52%



Penetration through ordinary clothing

- 16 studies, high crops (pome fruit/vineyard, early/late stages)
  - 288 replicates
  - Inner and outer dosimeters were sectioned closely matched
  - Torso and upper arms with t-shirt
  - Waist and thighs with shorts
  - To determine the penetration of spray droplets through the outer dosimeter (clothing)
- The mean penetration through t-shirts 5.12% and shorts 7.65% for both adult and child mannequins. The overall mean penetration is 6.39%
- In the graphs, dashed line --- shows the EFSA default 50%



Conclusions

- The %reduction is similar between crops; therefore, a single AF value covering all crops can be derived
  - One exception was for early-stage vineyard scenarios which could be considered individually to avoid unnecessary conservatism for the other scenarios
- The mean percentile %reduction from ordinary light clothing, covering adult/child, low/high crops, standard/drift-reducing nozzles, was 42.7%, resulting in AF of 0.57 (vs current 0.82)
- As a result, by not changing any other parameter, the spray drift exposure estimation would be reduced by 30% as compared to the current EU approach
- This evaluation demonstrates the current AF to be overly precautionary, and a more realistic, exposure scenario-relevant value could be applied for bystander/resident risk assessments

References

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  - CropLife Europe
- Current and former members of CropLife Europe Occupational and Bystander Exposure Technical SubGroup (OBE TSG)

Thank you for your attention!
Any questions?

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Annex – backup slides

Potential and actual exposure

- The potential and actual dermal exposures on mannequins were measured as “mg/person”, and then converted to “mL spray/person” by considering the concentration of the in-use spray dilution, i.e., mg/mL
- Potential exposure (= no clothing): a sum of AI residues on outer and inner dosimeters
  - i.e., t-shirt and shorts, the underwear (long sleeved t-shirt and long underwear trousers) and the head sleeve
- Actual exposure (= ordinary clothing): AI residues on inner dosimeters
  - i.e., long sleeved t-shirt and long underwear trousers and the head sleeve

Validation of penetration and %reduction

- To validate the penetration and determine a reduction factor from light clothing, a more detailed refinement of covered body areas was considered
- The body surface areas according to EFSA GD are not sufficiently stratified for this purpose. Data from US EPA Exposure Factors Handbook were used (US EPA 2011)
- According to US EPA, the mean surface area covered for an adult male is 54% of the whole body. For a child (2 yrs. old, male and female), the mean covered surface area is 64% when the t-shirt fully covers the upper arm, and the shorts fully cover the thigh. If the t-shirt covers half of the upper arm and the shorts cover half of the thigh, the mean covered surface area is 52%
- By refining the covered body surface area (52%) and including the protection from light clothing (93.61%–derived from the analysis of the current data set), the reduction from light clothing is 48.68%, i.e., in agreement with mean reduction % 42.7% (EFSA assumes 18%)

Discussion - conservatism

- The studies were conducted under representative label recommendations and field application conditions and represent conservative measurements
- The trials depicted a highly unlikely scenario with respect to the proximity of mannequins to the source of application, e.g., the mannequins were positioned facing the treated area at various distances downwind from the zero position (static location), with prevailing wind direction at approximately 90° angle to the orientation of the rows and/or direction of spray
- It is extremely unlikely that any person, be it bystander or resident, would spend an extended period of time in a direct spray drift without being aware of the spraying event taking place (EFSA et al. 2022)
- The total number of passes in the studies were 2–30 in different crops, which corresponds to exposure duration of 2 min to more than 1 hour
- By contrast, bystander exposure duration while walking, running or cycling past a simultaneously sprayed field would be very short

Discussion – clothing material and type

- The current data address the penetration through, and protection provided by cotton and cotton/polyester clothing, and further consideration could be given for other types of clothing materials (e.g., synthetic or semi-synthetic fabrics such as acrylic, nylon, rayon etc.) with a potentially higher penetration factor than cotton, cotton/polyester or wool clothing
- The exposure reduction due to clothing does not address different seasonal clothing in different climates and weather conditions (e.g., March in Northern Europe or July in Southern Europe), nor the activity in which the bystander or resident might be engaged in
- In colder climates, wearing long-sleeved shirt or jacket and long trousers, a relevant protection factor could be addressed accordingly. However, if bystanders are wearing full clothing, the clothing would be capable of absorbing the contaminants to some extent and so reduce their likely level of actual dermal exposure
- In warmer months of the year or warmer climates, bystanders/residents may be wearing less clothing than t-shirt and shorts, e.g., bathing suits. Further consideration should be given for the covered body surface area as well as the impact of the clothing material on the exposure reduction factor

Discussion – harmonization of exposure assessment

- In “spray drift”, “surface deposits”, and “entry into treated crop” scenarios, a certain amount of exposure may be reduced due to ordinary clothing. However, the assumptions and protection provided by light everyday clothing is not addressed consistently in the risk assessment process
- Different assumptions for clothing are applied
  - *Spray drift scenario* assumes only the trunk is covered
  - *Surface deposits scenario*, TC values consider a minimal protection from clothing, however, no further clarification of the covered body parts is available
  - *Entry into treated crops* assumes that lower legs and arms are uncovered
- Exposure assessment assumes a single person is being exposed via 4 different pathways, harmonization of the provided clothing and protection should be considered accordingly