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POTENTIAL SPRAY DRIFT EVALUATION OF AIRBLAST SPRAYER

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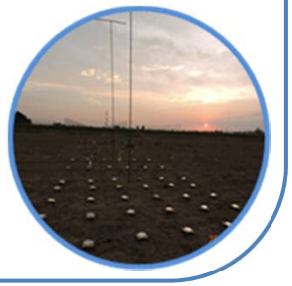
QUANTIFYING SPRAY DRIFT….

Currently, the unique standardized procedure officially recognized to assess spray drift amount generated by **PAE used in tree/bush crops**, and to classify their drift reduction performance is that provided by **ISO22866:2005**

Difficulties to apply ISO field layout

- **Difficulties to find a suitable crop (rows orientation) in relation to the site-specific wind characteristics**
- **Bare soil parcel downwind to the sprayed area**



Difficulties to meet the athmospheric conditions required by ISO

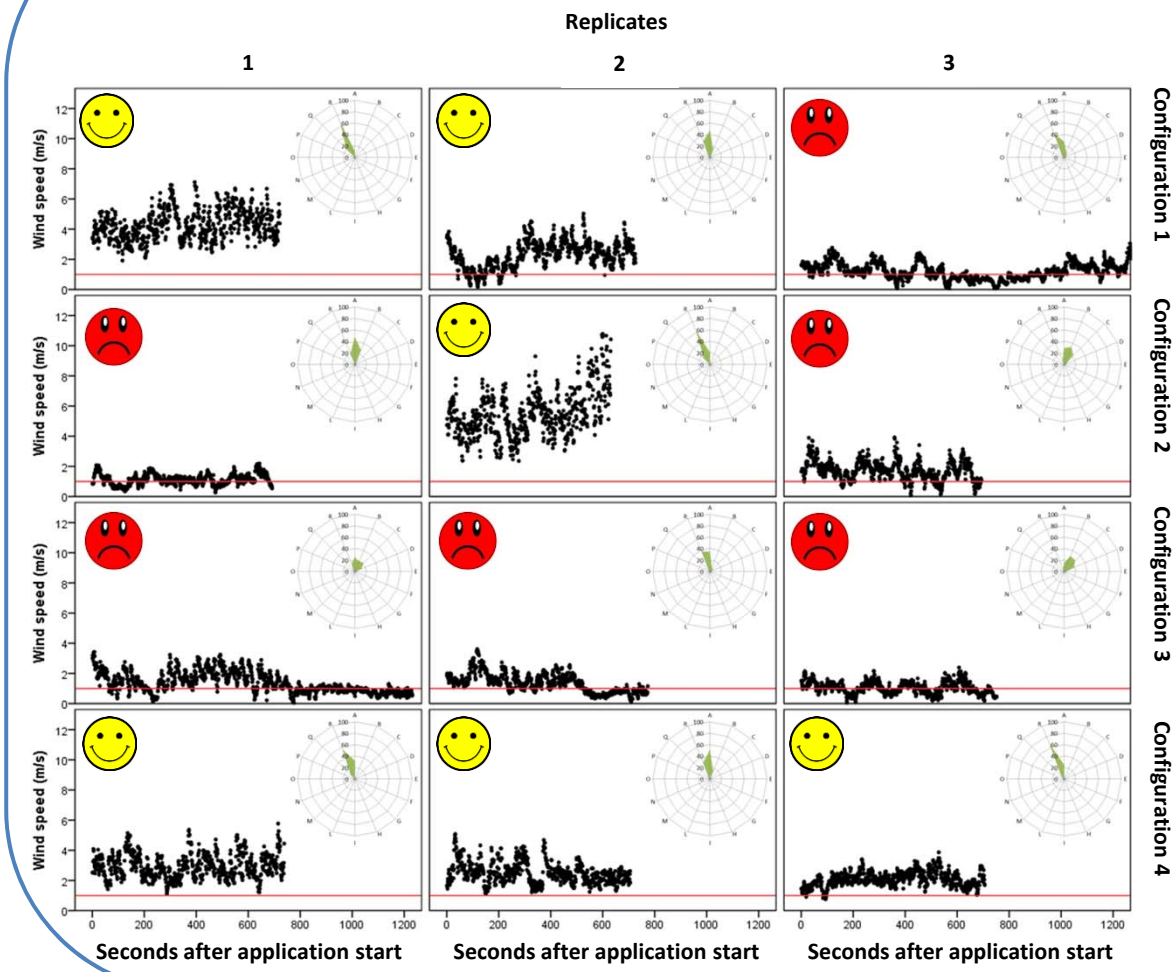
- **Air temperature between 5 and 35°C**
- **RH (no limitation)**
- **Wind speed**

- Mean > 1m s^{-1}
- Minimum and maximum (no limitation)
- Outliers (< 1m s^{-1}) < of 10% of records (using 1Hz sampling frequency)

- **Wind direction**

- Mean between 90 ± 30° azimuth (spray track)
- Centered direction (no more than 30% of records shall be > 45° azimuth from the perpendicular of the spray track)

Example of wind conditions recorded during drift trials in orchard



Only 50% of trials accomplish the environmental ISO requirements

DIFFICULT TO OBTAIN COMPARABLE AND REPEATABLE RESULTS USEFUL FOR COMPARATIVE PAE DRIFT CLASSIFICATION

NEED TO DEVELOP AN ALTERNATIVE TEST METHOD TO PERFORM COMPARATIVE ASSESSMENT OF SPRAY DRIFT GENRATED BY AIRBLAST SPRAYERS

ALTERNATIVE TEST METHOD SMART
AIMED TO EASILY AND PROPERLY CLASSIFY THE PAE AS A FUNCTION OF THEIR DRIFT REDUCTION PERFORMANCE

AVOIDING THE UNCONTROLLABLE VARIABLES THAT STRONGLY AFFECT FINAL RESULTS

~~**ATMOSPHERIC CONDITIONS**~~

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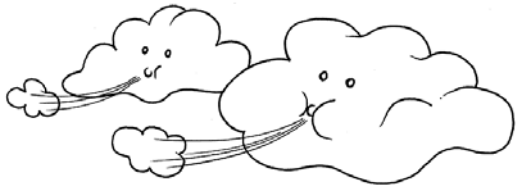
Overall wind effect



~~**CROP TYPES**~~

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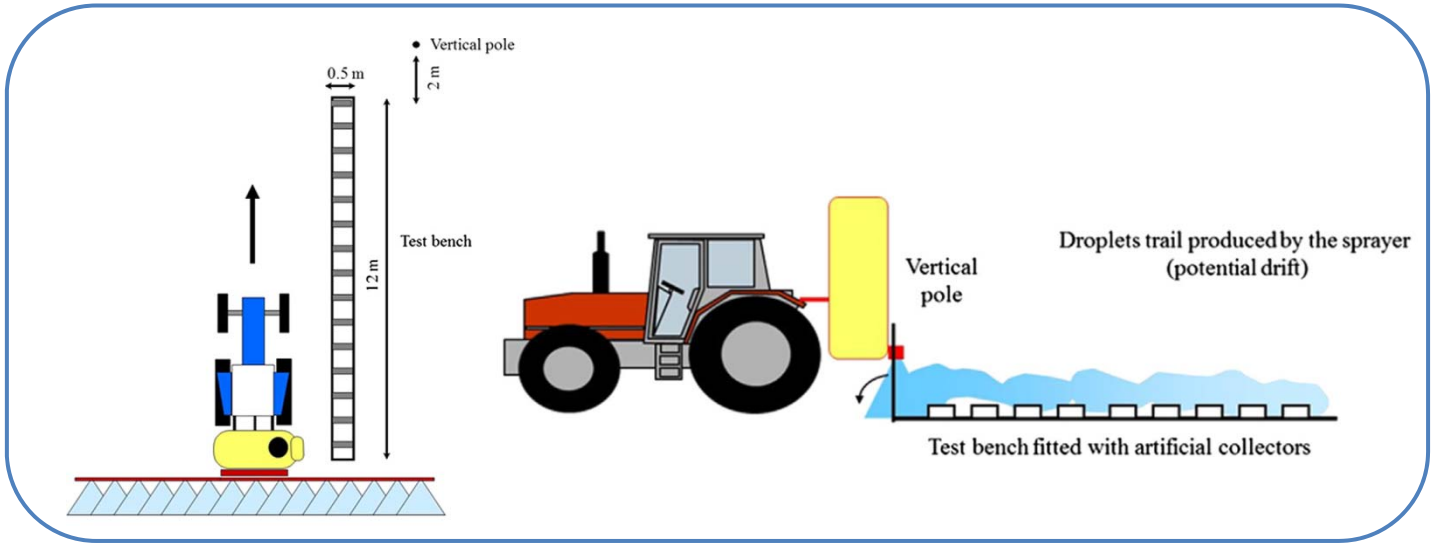
- Canopy architecture
- Development
- Layout of plantation
- Training system
- Growth stage

MOVE FROM “REAL” DRIFT VALUE TO "POTENTIAL" DRIFT AS DONE FOR FIELD CROP SPRAYERS

Currently for FIELD CROP SPRAYERS exist an alternative method to ISO22866:2005

ISO22401:2015

Equipment for crop protection- Methods for measurement of potential drift from horizontal boom sprayers systems by use of a test bench.



AIMS

DEVELOP A TEST METHOD ABLE TO ASSESS POTENTIAL SPRAY DRIFT OF THE DIFFERENT PAE USED FOR BUSH/TREE CROPS AND THEIR SETTINGS

DRIFT POTENTIAL

Relative drift values obtained from tests performed in NEARLY ABSENCE OF WIND and WITHOUT CROP/TARGET

NEARLY ABSENCE OF WIND

to minimize the variability of results when comparative measurements were needed

ABSENCE OF TARGET

very difficult to standardize an artificial target useful for all the bush/tree vegetation types and conditions.

AIMS

CURRENTLY IN ITALY OVER 1000 MODELS OF PAE USED IN BUSH/TREE CROPS ARE COMMERCIALIZED

POTENTIALLY EACH OF THEM SHALL BE TESTED TO DETERMINE THEIR PERFORMANCE IN DRIFT REDUCING (ISO16119-3:2013)

AN OBJECTIVE AND SMART METHODOLOGY FOR DRIFT EVALUATION/CLASSIFICATION OF PAE USED IN BUSH/TREE CROPS IS REQUIRED!!!

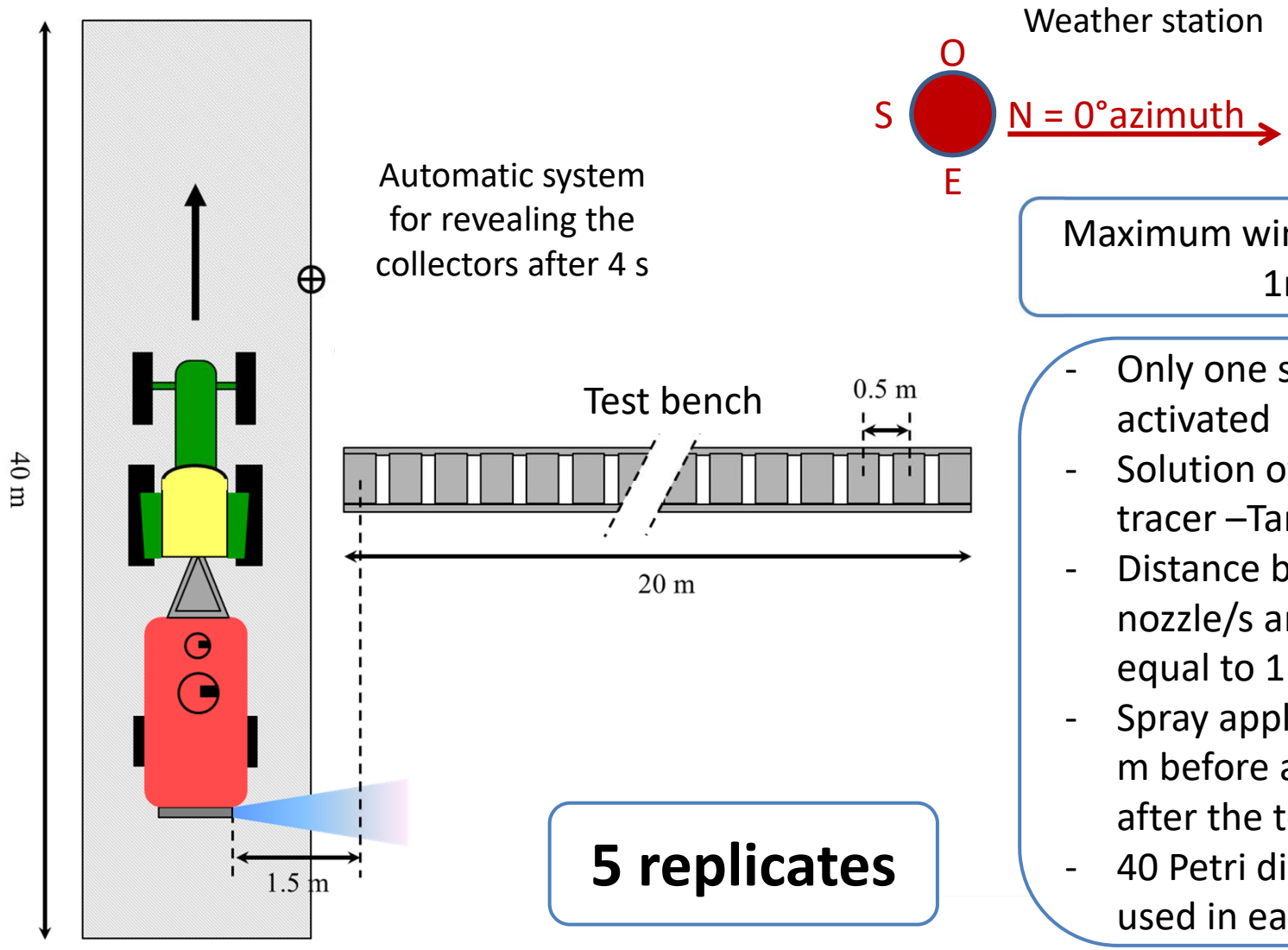
If sprayer settings are considered VERY HIGH NUMBER OF COMBINATIONS (PAE&Settings) HAVE TO BE EVALUATED!!!

THE PROPOSED METHODOLOGY

USE OF THE TEST BENCH DEVICE AS FOR ISO22401:2015

Aim of test bench is to collect the free floating fraction of liquid sprayed that remains suspended over the bench and is potentially subject to drift (Drift Potential).

LAYOUT OF TEST



Maximum wind speeds below 1m s^{-1}

- Only one sprayer's side activated
- Solution of yellow dye tracer –Tartrazine E102-
- Distance between outer nozzle/s and test bench equal to 1.5 m
- Spray application start 20 m before and stop 20 m after the test bench
- 40 Petri dishes collectors used in each replicate

5 replicates

-AT THE END- Laboratory analysis to determine the amount of tracer recovered

DRIFT POTENTIAL VALUE CALCULATION (DPV)

$$DPV = \sum_{i=1}^{n} D_i * Coeff$$

- ***DPV*** **is the drift potential value used as adimensional number**
- D_i **is the spray deposit on a single deposit collector, in µL cm^{-2}**
- ***n*** **is the number of collectors (40)**
- ***Coeff*** **is a variable coefficient based on the cumulative deposition curve obtained from the spray deposit measured on every single collector.**

DRIFT POTENTIAL VALUE CALCULATION: (*Coefficient* calculation)

$$Coeff = \sum_{n=1}^{10} Dst_{n*10}$$

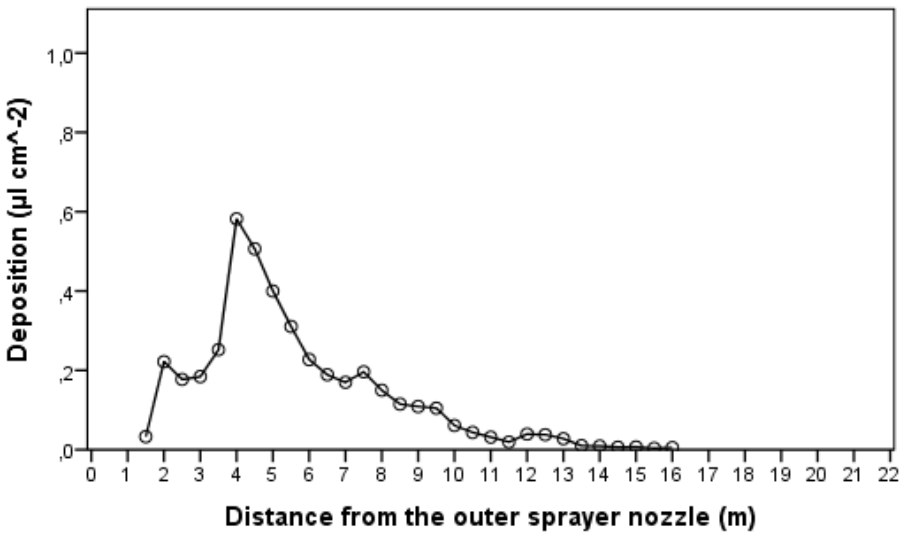
- ***Coeff*** **is the variable coefficient in m**
- Dst_{n*10} **corresponds to the value equal to the distance in meters from the outer sprayer nozzle where** $_{n*10}$ **% of the cumulative spray drift deposit calculated is achieved (i.e., from 10% to 100% in intervals of 10%).**

DRIFT POTENTIAL VALUE CALCULATION: *(Coefficient* calculation)

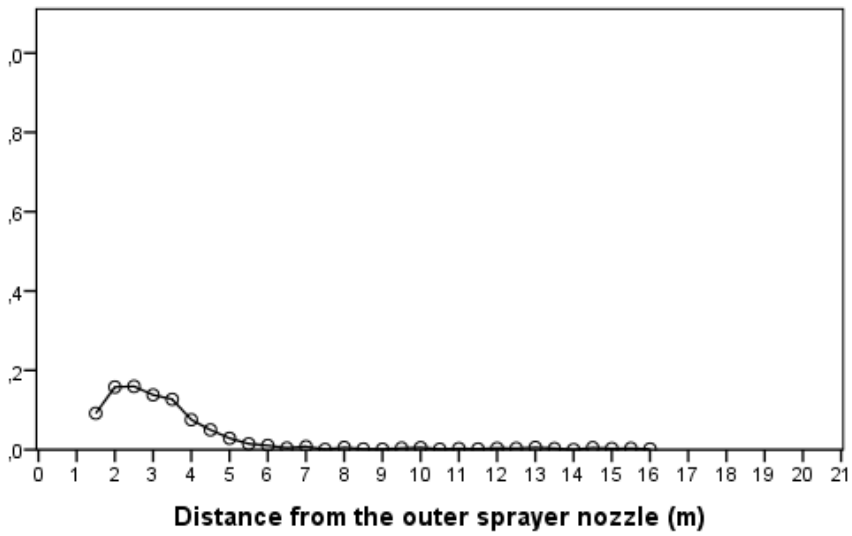
e.g. Sprayer settings **A** (conventional nozzles) and **B** (drift-reducing nozzles)

Sprayer settings A and B generate different potential drift curves, (different total deposition amount and displacement of deposits at the different distances from the sprayer)

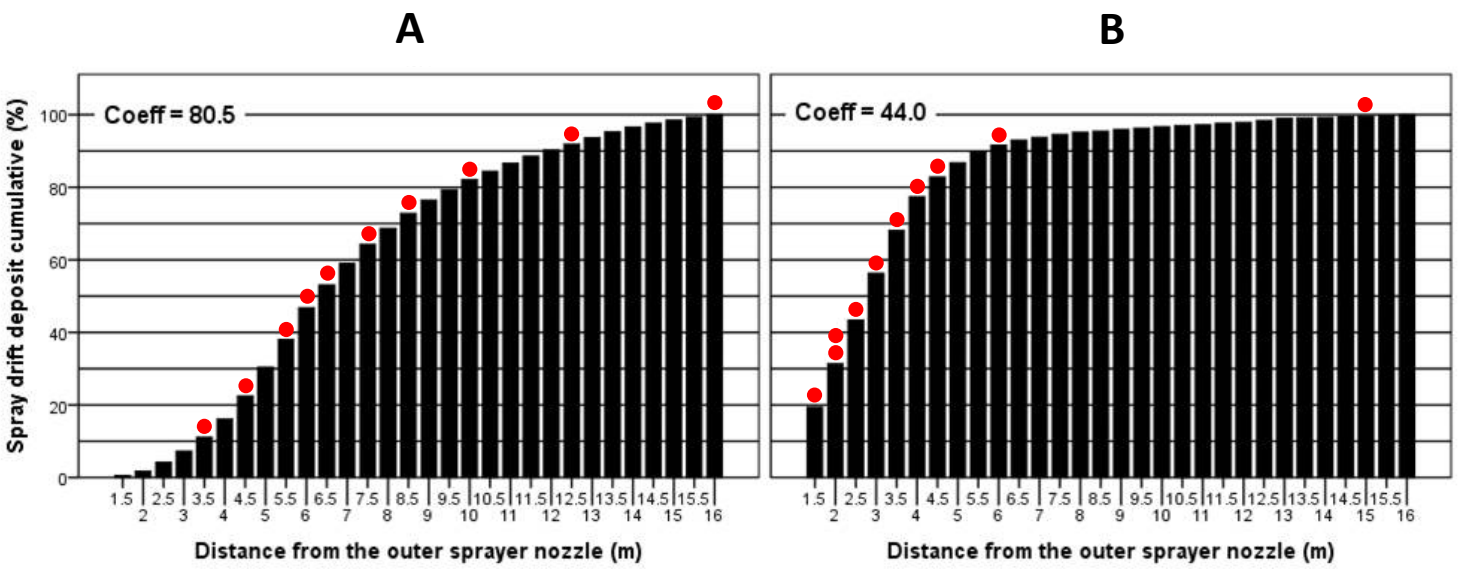
A



B



DRIFT POTENTIAL VALUE CALCULATION: *(Coefficient* calculation)



Setting A:

3.5+4.5+5.5+6+6.5+7.5+8.5+10+12.5+16

Coeff = 80.5

Setting B:

1.5+2+2+2.5+3+3.5+4+4.5+6+15

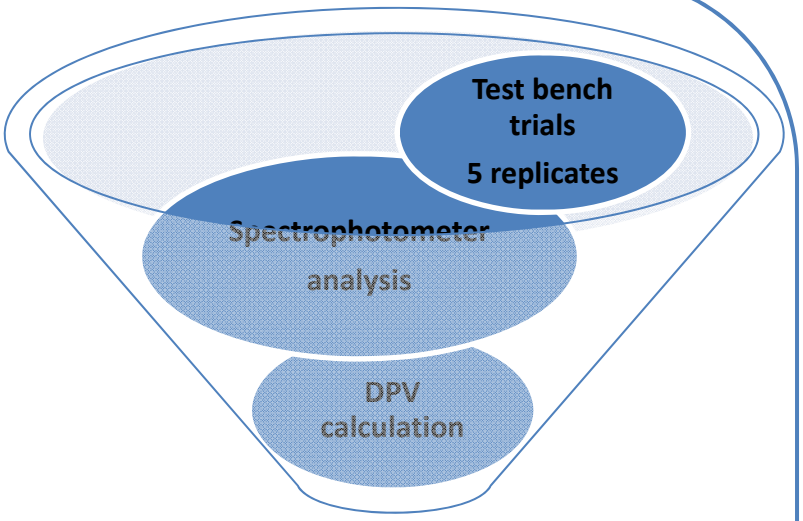
Coeff = 44.0

The higher the spray drift deposit accumulated close to the sprayer, the lower is the coefficient applied in the calculation of the *DPV*.

THE COEFFICIENT REWARDS THE SPRAYER SETTINGS THAT ACCUMULATE THE HIGHEST AMOUNT OF SPRAY DRIFT CLOSE TO THE SPRAY SOURCE!!!

EVALUATION OF POTENTIAL DRIFT

THE WHOLE PROCEDURE



Drift Potential Value (DPV) –
obtained from the mean of DPV calculated for each replicate

Adaptation of drift reduction (%) calculation method (ISO22369-1:2006):

$$DPV_{reference} : 100 = DPV_{candidate} : X$$

$$DP_{riduction}\ [\%]=100-(100*DPV_{candidate}/DPV_{reference})$$

CLASSIFICATION
following ISO22369-1:2006 classes

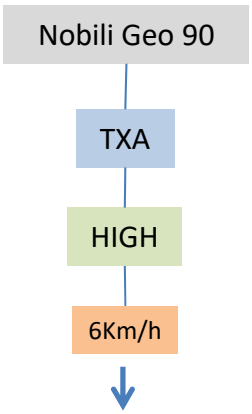
TRIALS PERFORMED

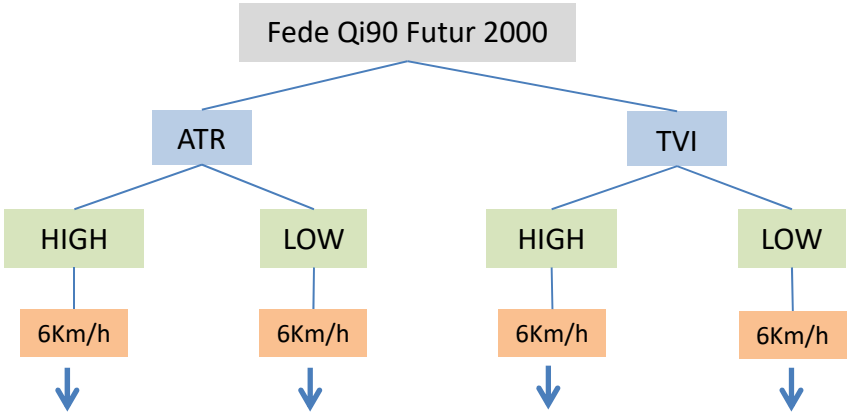
REFERENCE PAE
Sprayer: Nobili Geo 90
Nozzles type and total flow rate:
- TXA8001VK (active n° 9 → 23.40 L min^{-1})

Fan air volume: HIGH (51,000 $m^3 h^{-1}$)
Forward speed: 6 Km/h

CANDIDATE PAE
Sprayer: Fede Qi90 Futur 2000
PAE SETTINGS
Nozzles types and total flow rate:
- ATR80 red (active n° 8 → 18.64 L min^{-1})
- TVI80025 (active n° 8 → 17.92 L min^{-1})

Fan air volume: HIGH (46,000 $m^3 h^{-1}$), LOW (29,000 $m^3 h^{-1}$)
Forward speed: 6 Km/h





Configurations: Nobili_TXA6H **VS.** Fede_ATR6H Fede_ATR6L Fede_TVI6H Fede_TVI6L

TIME REQUIRED

- ≈ 1 minute required for spray application (6 km/h)
- 1 minute after spray application (time needed to allow the free floating droplets deposition)
- ≈ 4 minutes to collect and replace the 40 Petri dishes collectors (two operators)

TOTAL TIME REQUIRED FOR EACH REPLICATE
≈ 6 MINUTES

AGAINST

TOTAL TIME REQUIRED FOR EACH REPLICATE APPLYING ISO22866:2005
≈ 25 MINUTES

- ≈ 10 minutes required for spray application of 1000 m^2 in orchard (6 km/h, five rows of 60m length and distance between rows 4m)
- ≈ 4 minutes required for technical times (e.g. tractor maneuver, etc.)
- 1 minute after spray application (time needed to allow the free floating droplets deposition)
- ≈ 10 minutes to collect and replace the 60 Petri dishes collectors (two operators)

TEST BENCH METHOD REDUCES OF 33% THE NUMBER OF SAMPLES

ATMOSPHERIC CONDITIONS

Mean data, based on 5 replicates (1Hz frequency)

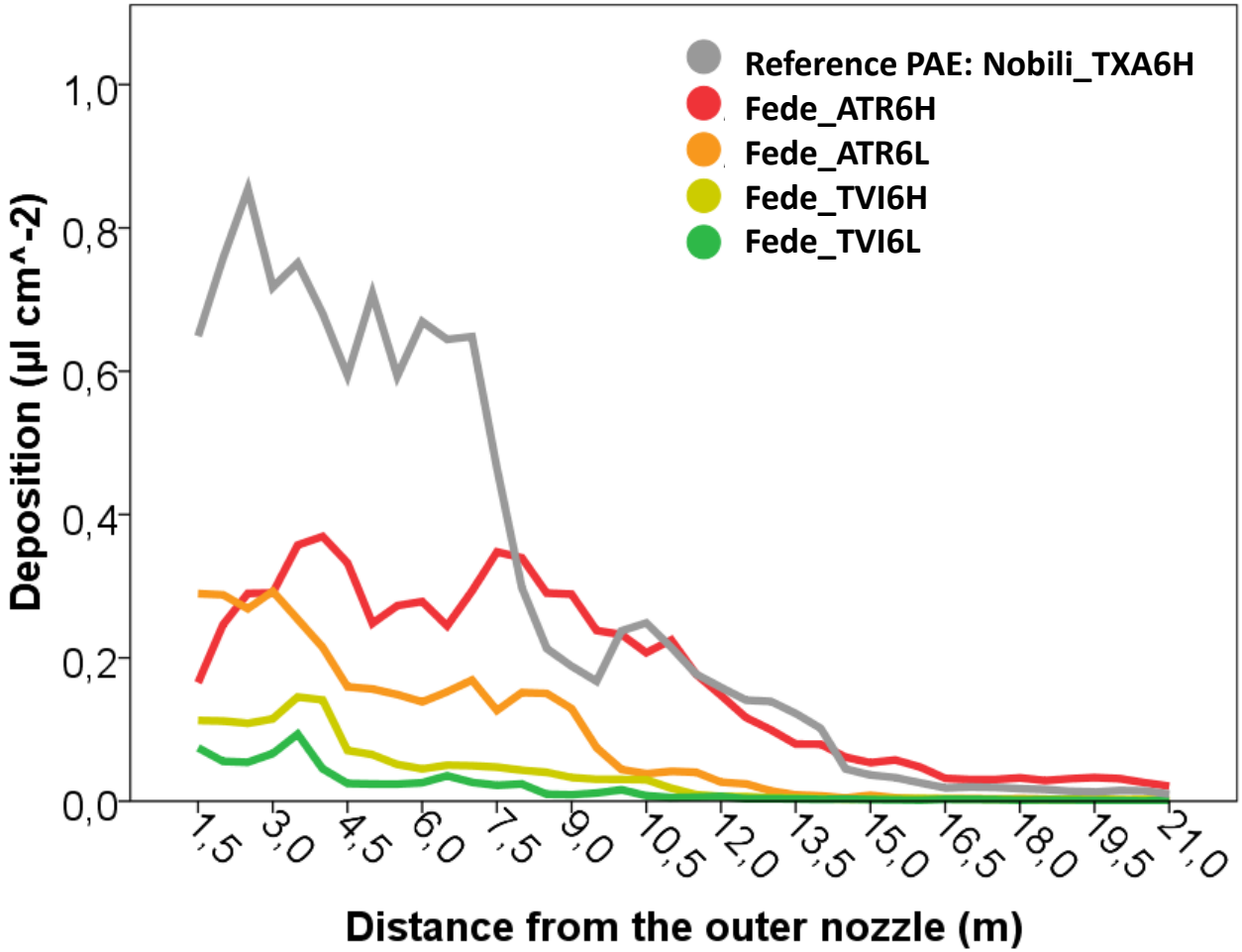
Configuration	Temperature MEAN [°C]	Relative Humidity MEAN [%]	Wind speed MEAN [m s^{-1}]	Wind speed MIN [m s^{-1}]	Wind speed MAX [m s^{-1}]	Wind direction* MEAN [°azimuth]
Reference Nobili_TXA6H	13.58	84.73	0.22	0.12	0.34	188
Candidate Fede_ATR6H	13.04	87.28	0.06	0.04	0.11	158
Candidate Fede_ATR6L	13.50	87.41	0.16	0.06	0.31	166
Candidate Fede_TVI6H	13.66	86.62	0.12	0.02	0.22	207
Candidate Fede_TVI6L	15.89	77.45	0.26	0.04	0.50	212

*relative to the spray track

LOWER THAN 0.3 m s^{-1}

LOWER THAN 0.5 m s^{-1}

DEPOSITION CURVES



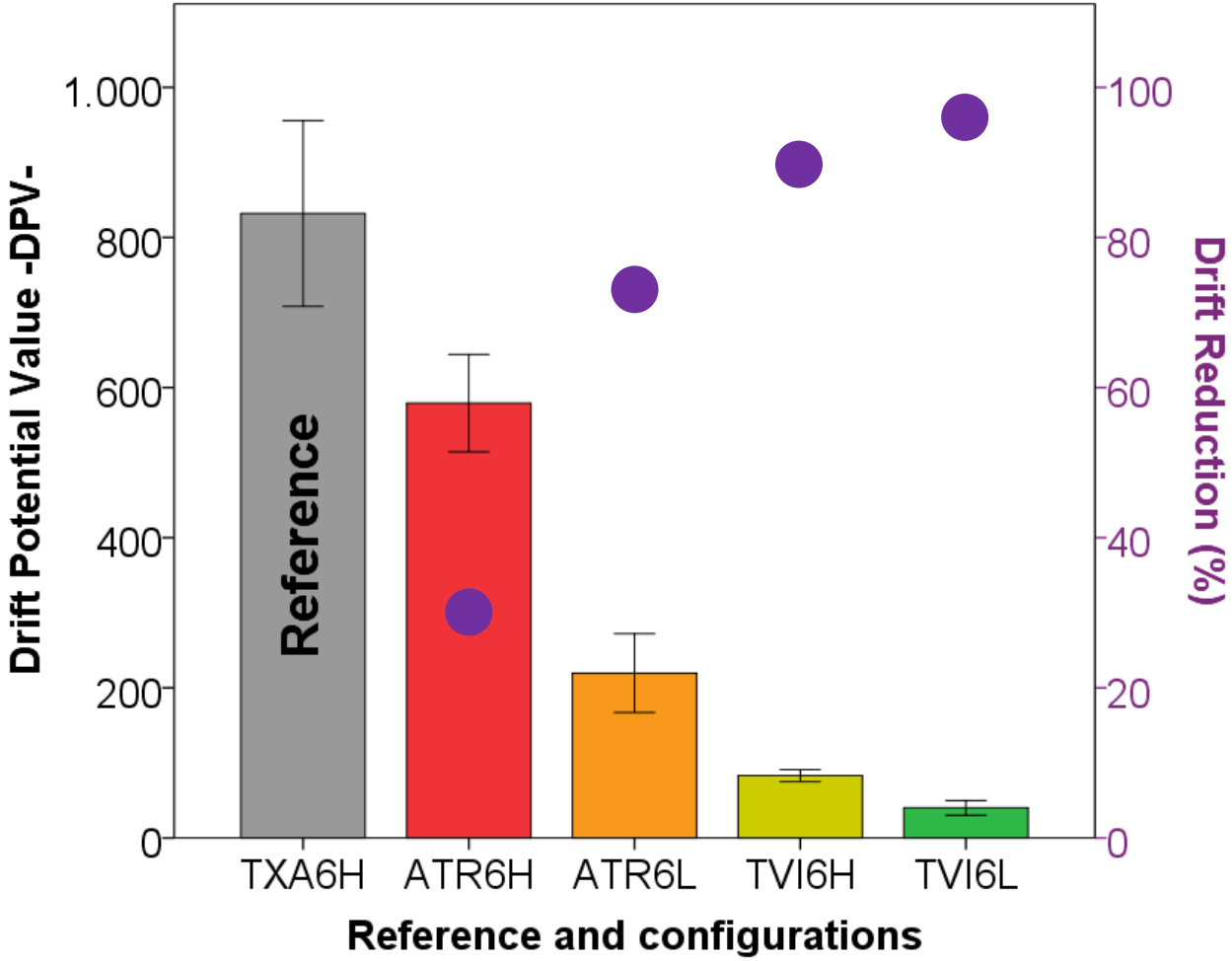
Spray deposit profiles (µL/cm²) obtained testing the reference and the candidates configurations.

COEFFICIENTS

The Coefficient is calculated for single replicate in order to obtain a DPV from each replicate

Configurations		Coefficient obtained in each replicate					MEAN	CV%
		Replicate 1	Replicate 2	Replicate 3	Replicate 4	Replicate 5		
Reference	Nobili_TXA6H	75.0	85.5	76.5	92.0	83.5	82.5	8.4
Candidate	Fede_ATR6H	78.0	85.0	93.0	98.5	89.0	88.7	8.8
Candidate	Fede_ATR6L	62.5	62.0	64.5	68.0	71.5	65.7	6.1
Candidate	Fede_TVI6H	59.5	50.0	55.0	48.0	56.5	53.8	8.8
Candidate	Fede_TVI6L	45.0	52.0	41.5	49.5	52.5	48.1	9.8

DRIFT POTENTIAL VALUES (DPVs)



DPVs obtained and bars ± SE of the mean; the dots shown the drift reduction (%) achieved by each candidate configuration relative to the reference configuration.

DRIFT REDUCTION VALUES OBTAINED (ISO22361-1:2006)

Configurations		Drift reduction (%)	Drift reduction class achieved
Reference	Nobili_TXA6H	-	-
Candidate	Fede_ATR6H	30,4	**F**
Candidate	Fede_ATR6L	73,6	**E**
Candidate	Fede_TVI6H	90,1	**C**
Candidate	Fede_TVI6L	95,2	**B**

Potential spray drift reduction (%) and classes of reduction achieved by PAE configurations tested according with ISO22369-1 (A ≥ 99 %, B 95 % ≤ 99 %, C 90 % ≤ 95 %, D 75 % ≤ 90 %, E 50 % ≤ 75 % and F 25 % ≤ 50 %.)

These preliminary studies introduce a proposal of a simple procedure for assessing the DPV of airblast sprayer

The candidate PAE adjustment tested (combination of nozzles type and fan air flow rate) show an effect in drift potential reduction, as expected

These first promissory results, give a concrete possible alternative to ISO22866:2005 for the drift reduction classification of airblast sprayers in a simple and repeatable way.

FURTHER STUDIES, TO MAKE THE PROPOSED METHOD MORE ROBUST, ARE NEEDED

WORK IN PROGRESS

DiSAFA Università di Torino

UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH → DEAB department

Studies are underway to…

…investigate the most properly setting of opening time of the test bench as a function of the sprayer forward speed tested

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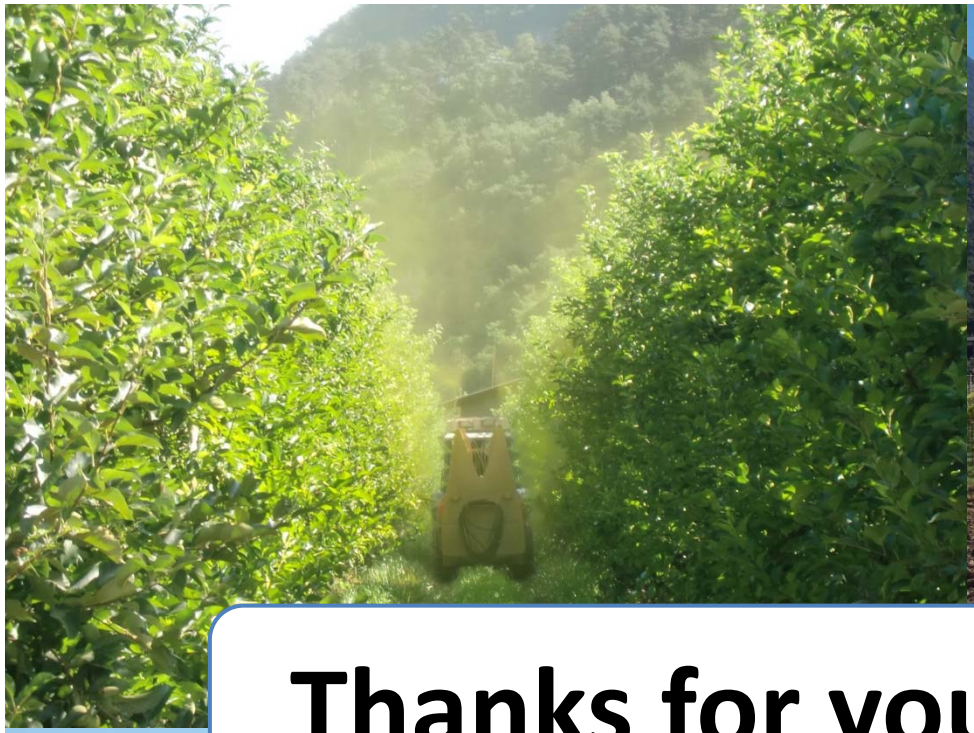
DPV and spray drift reduction need to be evaluated in a wide range of forward speeds

…investigate the suitability of the test bench to detect the spray drift potential from further types of air blast sprayers (i.e. pneumatic and cross flow fan sprayers)

…compare the spray drift potential risk obtained using the test bench (indirect method) and the spray drift risk obtained by applying the ISO22866:2005 field test method (direct method)



Thanks for your attention!!!

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