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VIII° International Congress on Mountain and Steep Slopes Viticulture

# Unmanned Aerial Systems for Crop Protection in Heroic Viticulture: An Eight-Year Field Assessment

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Piazzale delle Cascine, 15

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## HEROIC VITICULTURE IN TUSCANY

**Tuscan Archipelago  
Giglio Island**



**Massa-Carrara  
Colli di Candia**



## ENDED & ON-GOING PROJECTS

2017 ..... 2022 2023 2024 2025 2026 2027 2028



Autonomous  
research

Regione Toscana

The introduction of innovative drones to optimize plant protection in Tuscany's in excellence agricultural areas, with a view to reducing environmental impact, safeguarding the health of workers and bystanders, and maintaining competitiveness.



Autonomous  
research



Performance and Exposure Risks in Crop Protection Spraying Operations with Autonomous Aerial Systems

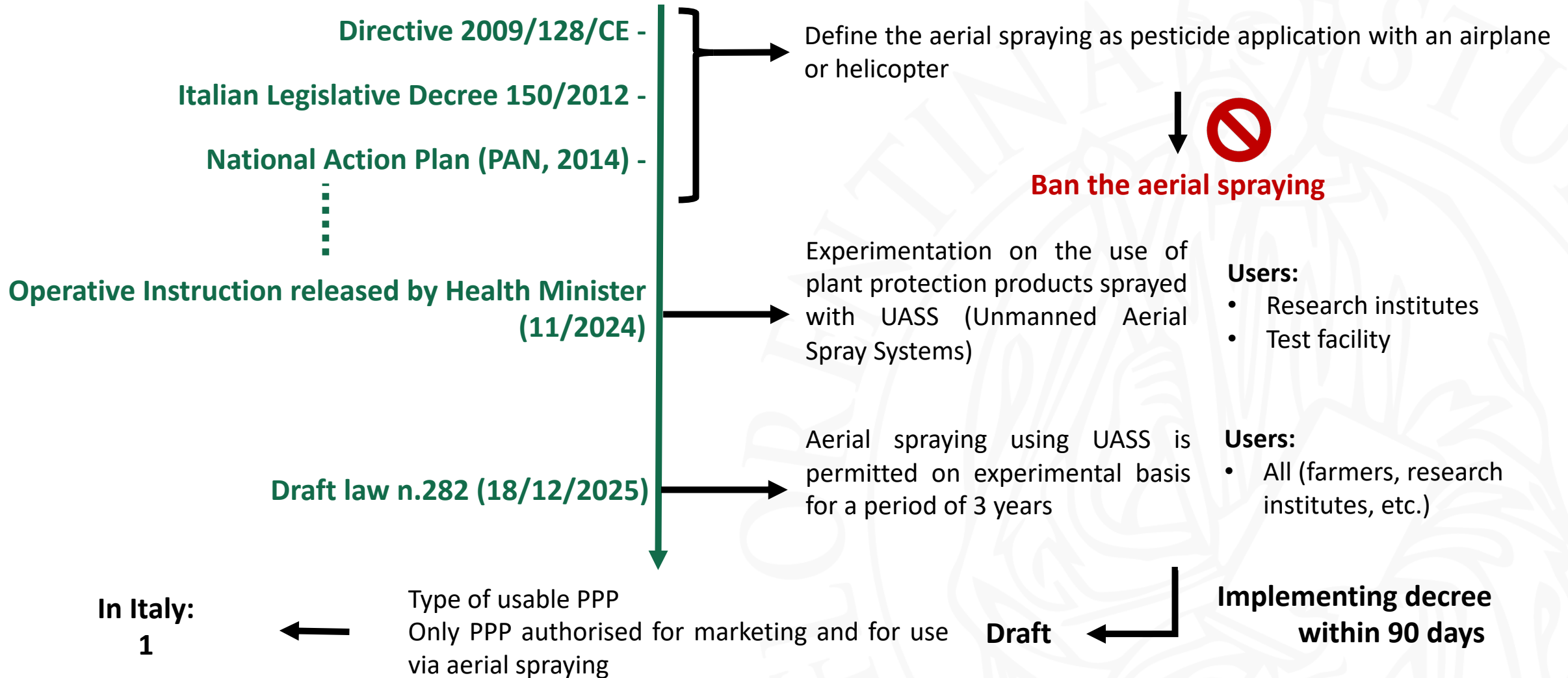
Bando Ricerche in Collaborazione  
(BRIC -2025)  
Piano Attività di Ricerca 2025-2027



Validation of drone applications for the optimized management of agricultural operations to increase the competitiveness and sustainability of typical Tuscan production in marginal and valuable areas

Regione Toscana

## ITALIAN LEGISLATION ABOUT CROP PROTECTION WITH DRONE



## TRIALS PROTOCOL



### WORK SCENARIO

Steep slope terraced vineyard (35°) – vine rows orthogonal to maximum slope lines

UASS vs. Manual spraying



### TECHNOLOGIES

BLY-C-AGRI

DJI Agras T10

DJI Agras T25

STIHL SR 430

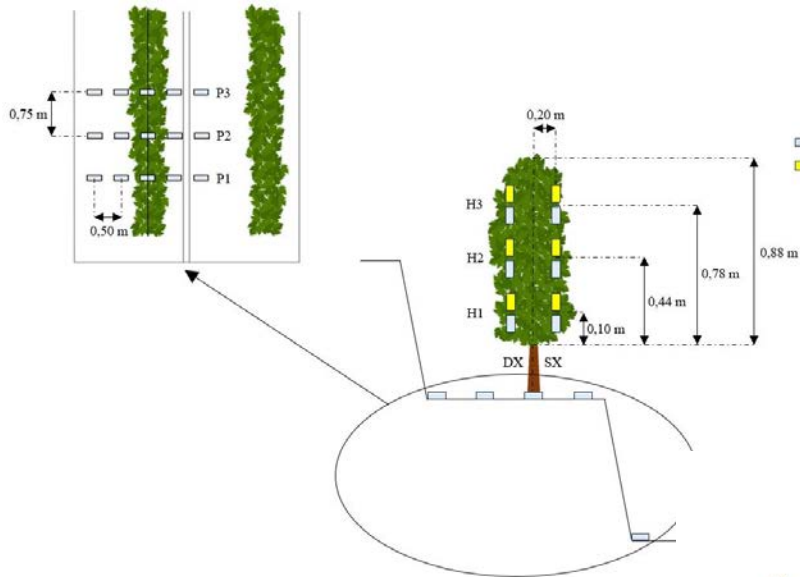


### ANALYSED VARIABLES

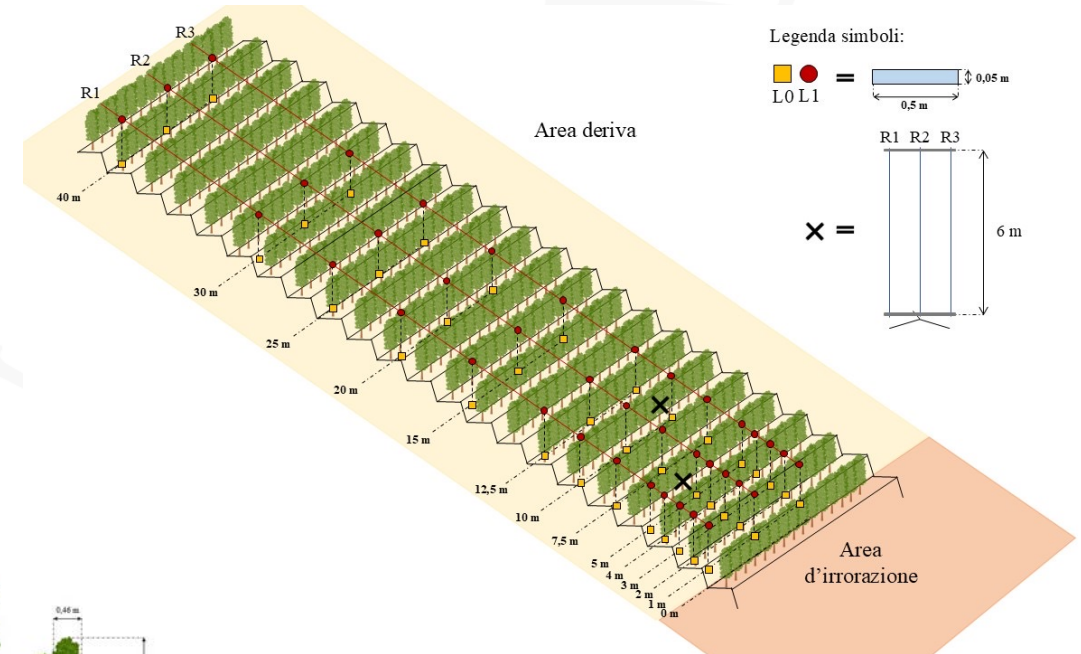
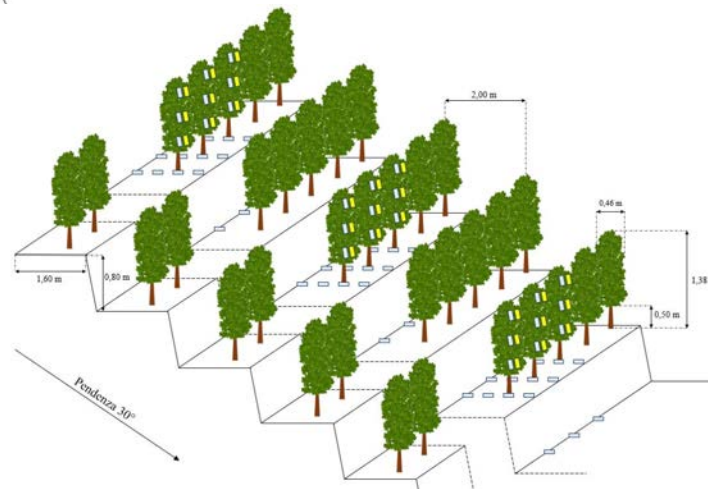
- Deposits & Coverage on canopy
- Ground losses
- Spray drift
- Worker exposure



## TRIALS PROTOCOL



Collettore in plastica  
Cartina idro-sensibile



Legenda simboli:

● = 0,05 m  
L O L 1 = 0,5 m

R1 R2 R3  
X = 6 m

### Canopy depositions & ground losses trials:

- ISO 22522:2007
- E102 Tartrazine (10 g L<sup>-1</sup>) + plastic sheets
- Water sensitive papers

### Spray drift & worker exposure trials:

- ISO 22866:2005
- E102 Tartrazine (10 g L<sup>-1</sup>) + plastic filaments
- Tyvek coveralls

## TRIALS PROTOCOL

### 2017 Trials – Bly-c-agri

| Trial            | Flight height<br>m | Application<br>volume<br>L ha <sup>-1</sup> | Forward speed<br>m s <sup>-1</sup> | Nozzles          | Path                    |
|------------------|--------------------|---|------------------------------------|------------------|-------------------------|
| Bly-c-agri 1     | 5                  | 250   | 0.5                                | XR8003           | Orthogonal to vine rows |
| Bly-c-agri 2     | 5                  | 250   | 0.5                                | AIXR11003        | Orthogonal to vine rows |
| Backpack sprayer | n.a.               | 120   | 0.7                                | n.a.             | Parallel to vine rows   |
| Sprayer gun      | n.a.               | 900   | 0.61                               | Hollow cone disc | Parallel to vine rows   |

\*Sarri et al. (2019)

### 2022 Trials – DJI Agras T10

| Trial | Technology       | Flight height<br>m | Application<br>volume<br>L ha <sup>-1</sup> | Forward<br>speed<br>m s <sup>-1</sup> | Nozzles   | Path                               |
|-------|------------------|--------------------|---|---------------------------------------|-----------|------------------------------------|
| A*    | Agras T10        | 3.5                | 100   | 1                                     | XR11002VS | Parallel to & above vine rows      |
| B     | Agras T10        | 3.5                | 100   | 1                                     | XR11002VS | Parallel to & above inter-rows     |
| C*    | Agras T10        | 3.5                | 100   | 1                                     | XR11002VS | Orthogonal to vine rows, one path  |
| D     | Agras T10        | 3.5                | 100   | 1                                     | XR11002VS | Orthogonal to vine rows, two paths |
| E     | Agras T10        | 3.5                | 50  | 1                                     | XR11002VS | Parallel to & above vine rows      |
| F     | Agras T10        | 3.5                | 50  | 1                                     | XR11002VS | Parallel to & above inter-rows     |
| G     | Agras T10        | 3.5                | 50  | 1                                     | XR11002VS | Orthogonal to vine rows, one path  |
| H     | Agras T10        | 3.5                | 50  | 1                                     | XR11002VS | Orthogonal to vine rows, two paths |
| I*    | Backpack sprayer | n.a.               | 120   | 0.5                                   | n.a.      | Parallel to vine rows              |

\* Spray drift & workers exposure trials

## TRIALS PROTOCOL

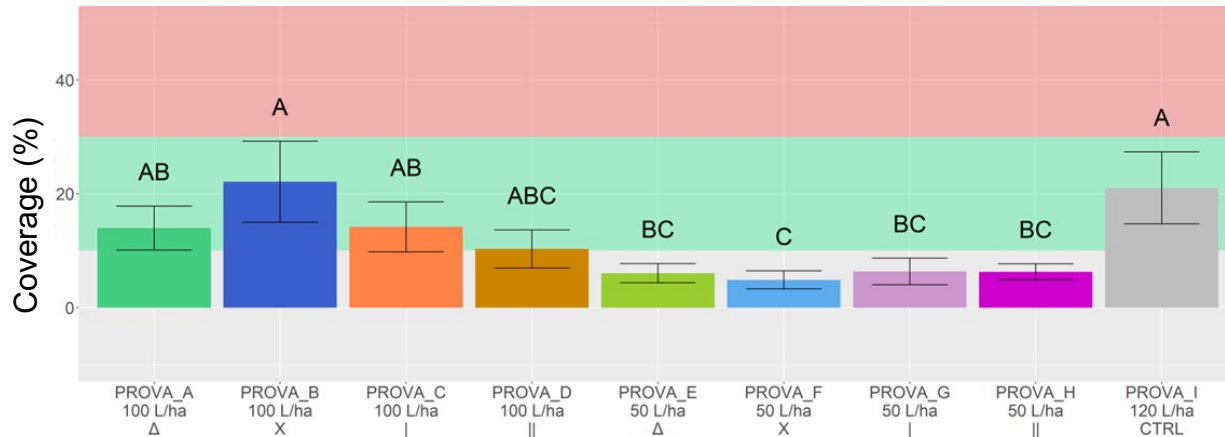
### 2025 Trials – DJI Agras T25

| Trial | Technology      | Flight height<br>m | Application volume<br>L ha <sup>-1</sup> | Forward speed<br>m s <sup>-1</sup> | Droplets dimension*<br>µm | Path                              |
|-------|-----------------|--------------------|--|------------------------------------|---------------------------|-----------------------------------|
| A     | Agras T25       | 3.5                | 400                                      | 1                                  | 150                       | Parallel to & above vine rows     |
| B     | Agras T25       | 3.5                | 400                                      | 1                                  | 300                       | Parallel to & above vine rows     |
| C     | Agras T25       | 3.5                | 400                                      | 1                                  | 150                       | Parallel to & above inter-rows    |
| D     | Agras T25       | 3.5                | 400                                      | 1                                  | 300                       | Parallel to & above inter-rows    |
| E     | Agras T25       | 5                  | 200                                      | 1                                  | 150                       | Orthogonal to vine rows, one path |
| F     | Agras T25       | 5                  | 200                                      | 1                                  | 300                       | Orthogonal to vine rows, one path |
| G     | Backpack spayer | n.a.               | 250                                      | 0.5                                | n.a.                      | Parallel to vine rows             |

\* Centrifugal nozzles LX8060SZ



## TRIALS CONDUCTED WITH DJI AGRAS T10 - 2022-2024



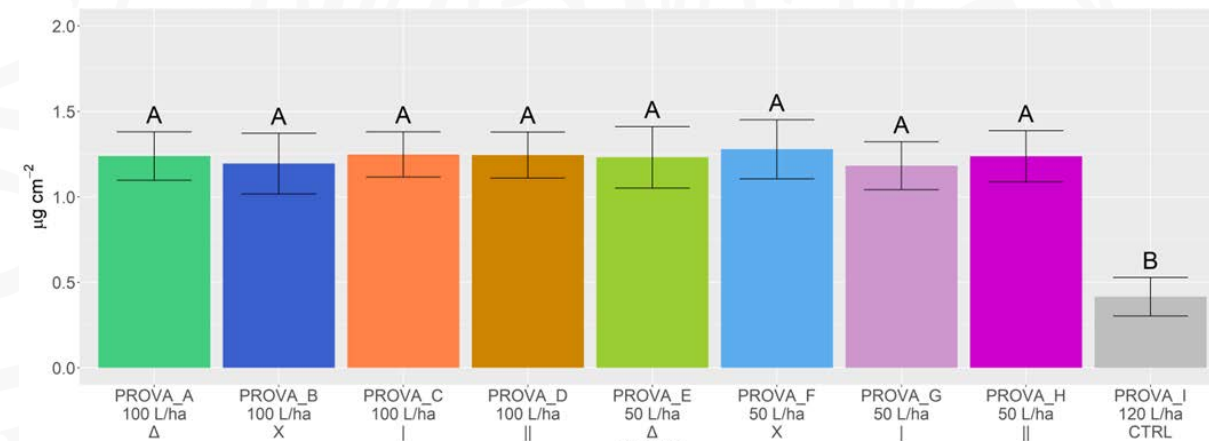
### Spray coverage on canopy:

- Only Test B statistically matched the results of Test I (Backpack sprayer) in terms of coverage (water-sensitive papers), it falls within the optimal coverage range (green background);



### Ground losses:

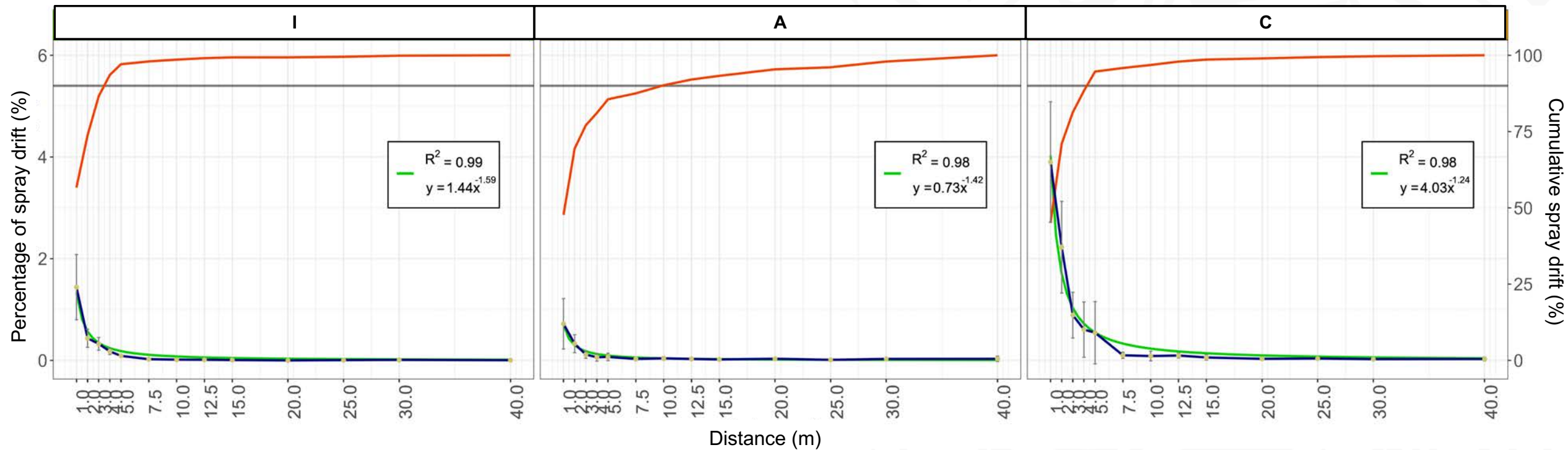
- Ground losses, measured in terms of normalized deposition, were approximately three times higher in all the drone tests compared with the control test (Backpack sprayer);



## TRIALS CONDUCTED WITH DJI AGRAS T10 – 2022-2024

### Spray drift:

- A less pronounced drift curve was generated with the UASS flying along the rows (Test A) compared to conventional method (Backpack sprayer).



## TRIALS CONDUCTED WITH DJI AGRAS T10 – 2022-2024

### FARMER

( $\mu\text{g } 100 \text{ cm}^{-2}$ )

### PILOT

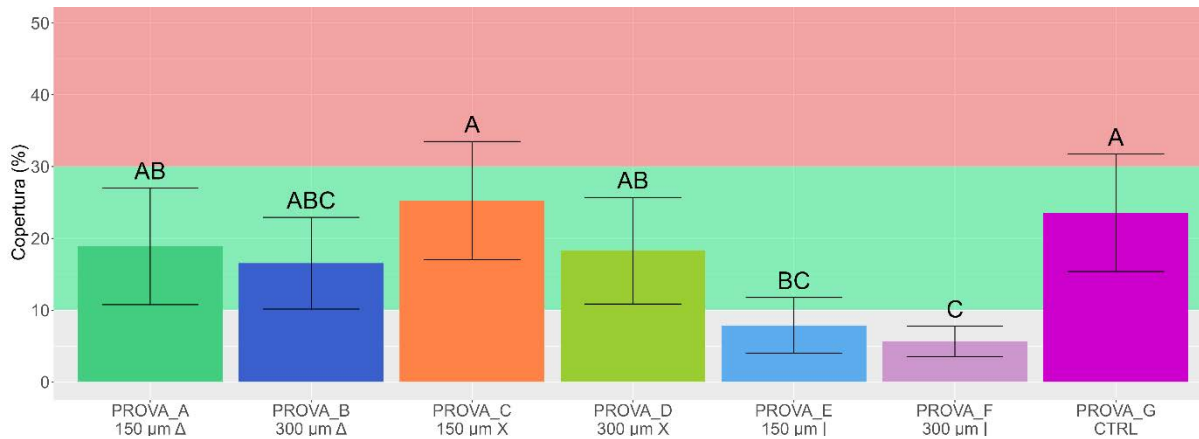
( $\mu\text{g } 100 \text{ cm}^{-2}$ )



| Samples       | Farmer | Pilot  | Ratio<br>Farmer<br>Pilot |
|---------------|--------|--------|--------------------------|
|               | %      | %      |                          |
| Head          | 5,01%  | 10,10% | 102                      |
| Chest         | 12,48% | 6,19%  | 415                      |
| Back          | 0,91%  | 4,74%  | 39                       |
| Left arm      | 4,59%  | 6,60%  | 143                      |
| Right arm     | 3,61%  | 4,33%  | 171                      |
| Left forearm  | 5,91%  | 12,99% | 93                       |
| Right forearm | 4,67%  | 8,04%  | 119                      |
| Left glove    | 14,85% | 10,10% | 302                      |
| Right glove   | 8,70%  | 19,38% | 92                       |
| Left tight    | 8,37%  | 1,86%  | 926                      |
| Right tight   | 7,75%  | 2,68%  | 594                      |
| Left leg      | 12,17% | 5,98%  | 418                      |
| Right leg     | 10,98% | 7,01%  | 322                      |



## TRIALS CONDUCTED WITH DJI AGRAS T25 – 2025..

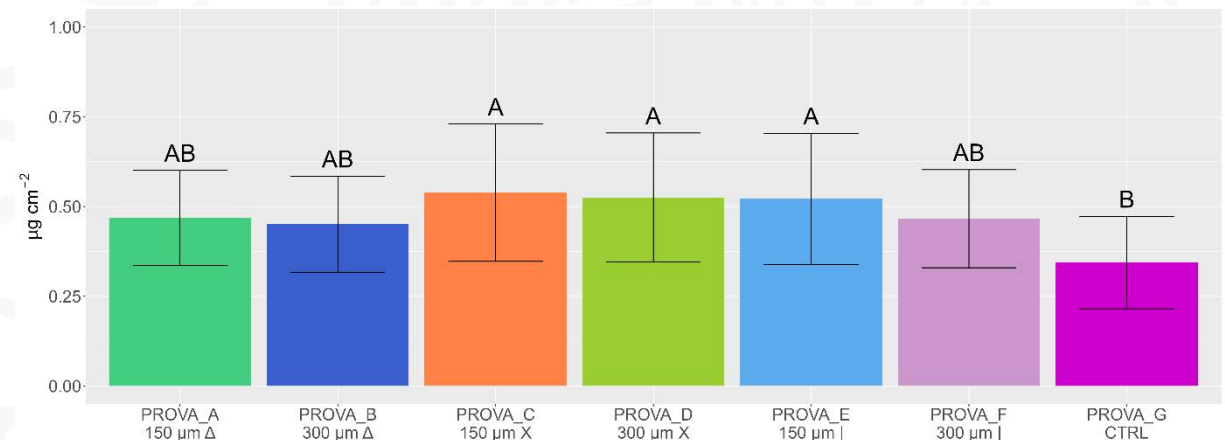


### Spray coverage on canopy:

- Only Test C statistically matched the results of Test G (Backpack sprayer) in terms of coverage (water-sensitive papers), it falls within the optimal coverage range (green background);

### Ground losses:

- Ground losses, in terms of normalized depositions ( $\mu\text{g cm}^{-2}$ ) are about 30% higher with UASS trials in relation to backpack sprayer, but the variation range was significantly lower compared to DJI Agras T10;



## CONCLUSION

### BLY-C-AGRI



- Poor spray quality, both in absolute terms and across the canopy;
- Coverage measured with UASS less than 5%;
- Lack of systems to maintain a constant flight altitude relative to the canopy;

### DJI AGRAS T10



- Only UASS trial parallel to vine rows are comparable to backpack sprayer in terms of spray coverage;
- Ground losses with UASS are about 3-fold higher in relation to backpack sprayer;
- Spray drift generated with UASS similar to backpack sprayer;
- Worker exposure (pilot vs. farmer) is about 300-fold lower;

### DJI AGRAS T25



- UASS trials parallel to vine rows are comparable to backpack sprayer in terms of spray coverage;
- Ground losses are about 30% higher with UASS in relation to backpack sprayer, variation range was significantly lower compared to DJI Agras T10;
- Spray drift not yet studied with ISO methodology (ISO 22866:2005);

## CROP PROTECTION WITH DJI AGRAS T25 IN 2026



### Ministero della Salute

Dipartimento della salute umana, della salute animale e dell'ecosistema (One health) e dei rapporti internazionali  
Direzione generale dell'igiene e della sicurezza alimentare  
Ufficio 7 - Sicurezza e regolamentazione dei prodotti fitosanitari

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Fascicolo:  
I.5.i.2.4/2026/4\_DGISA-UFF. 07 SPERIMENTAZIONI PF-DRONE

Id:

OGGETTO: istanza di permesso alla sperimentazione di prodotti fitosanitari distribuiti mediante drone (UASS) ai sensi dell'art. 54 del regolamento (CE) n. 1107/2009 "PROGETTO DRONE FARMING - VITICOLTURA EROICA"

In merito all'istanza in oggetto, vista la documentazione presentata ed acquisito il parere degli esperti della Sezione consultiva fitosanitari del Comitato tecnico per la nutrizione e la sanità animale, si rappresenta quanto di seguito.  
nulla osta all'esecuzione della sperimentazione in oggetto, per quanto di competenza.





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# THANK YOU FOR YOUR ATTENTION

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