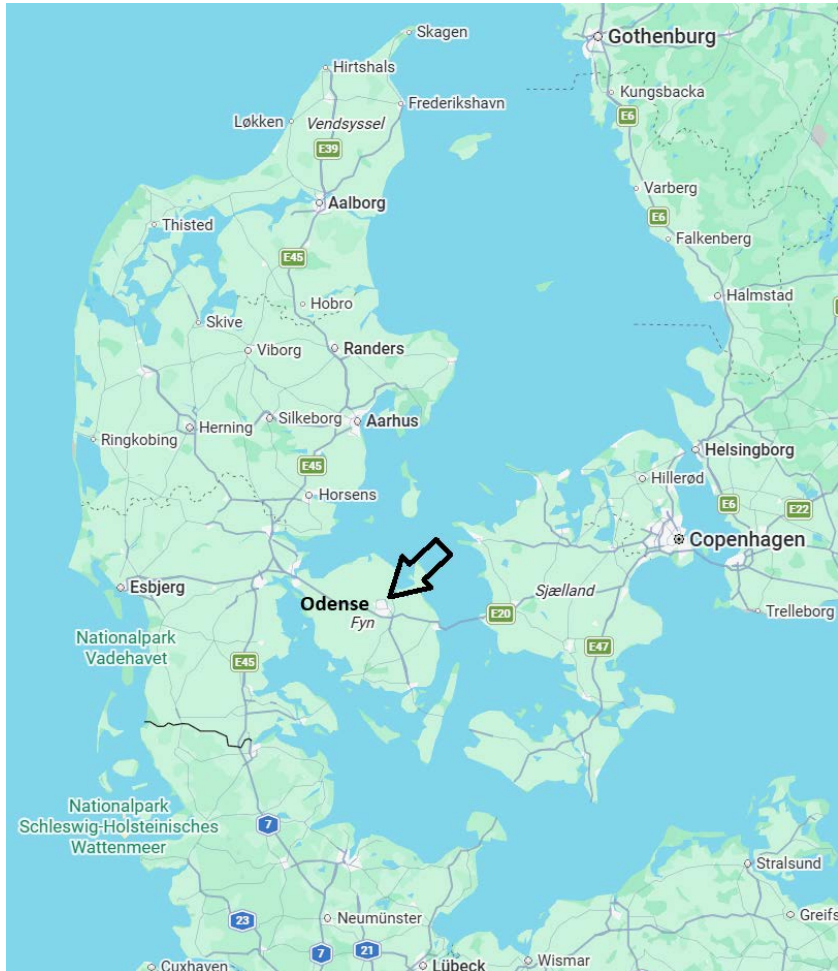




University of
Southern Denmark



Project: Plants for Peace

Combining advanced plant science and drone technology

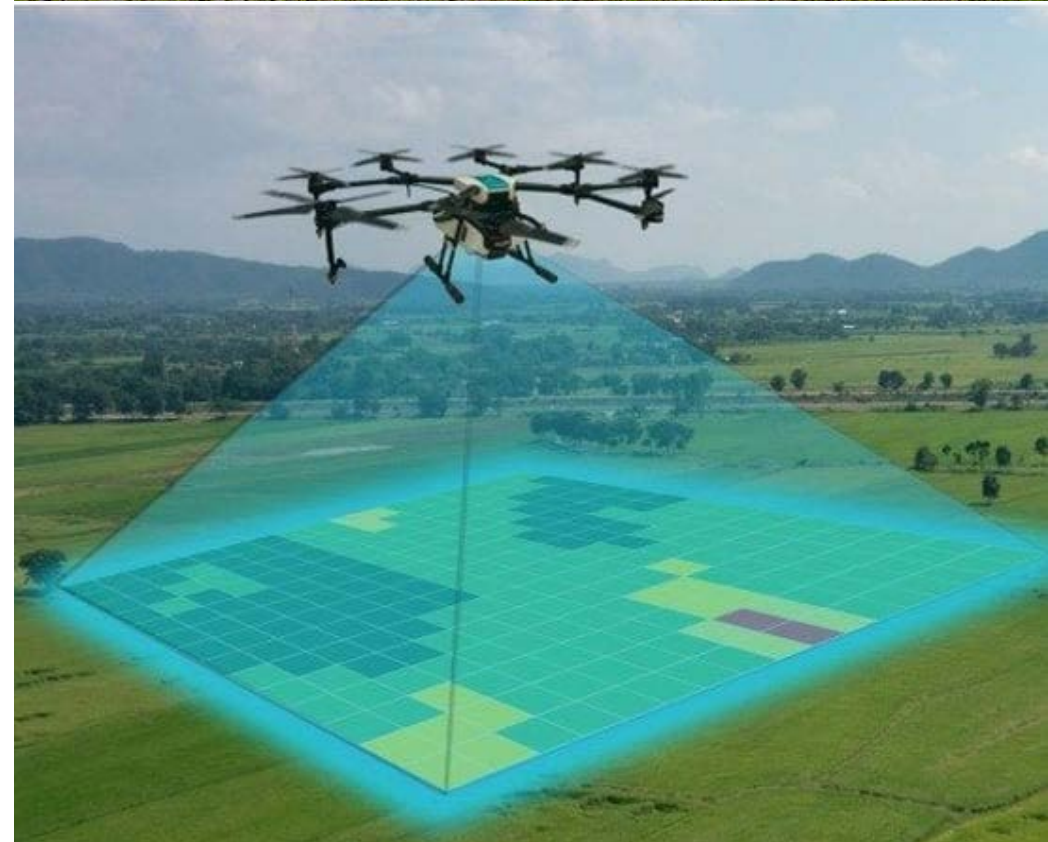
SPRAY-SEED-DETECT-REPORT

Affordable – for every farmer

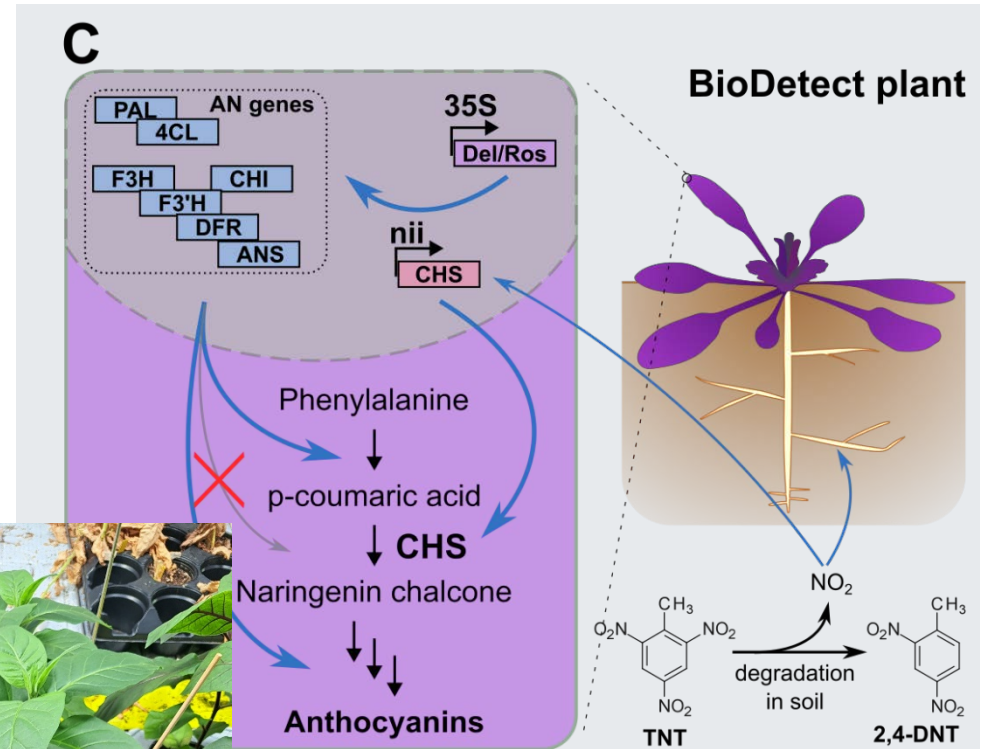
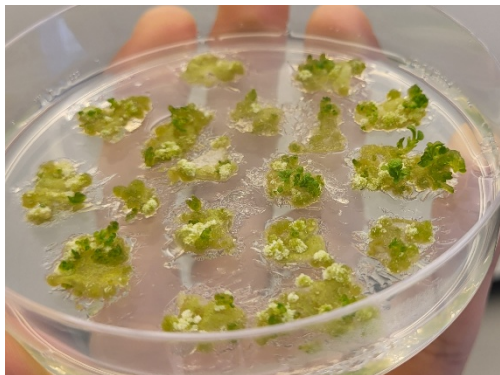
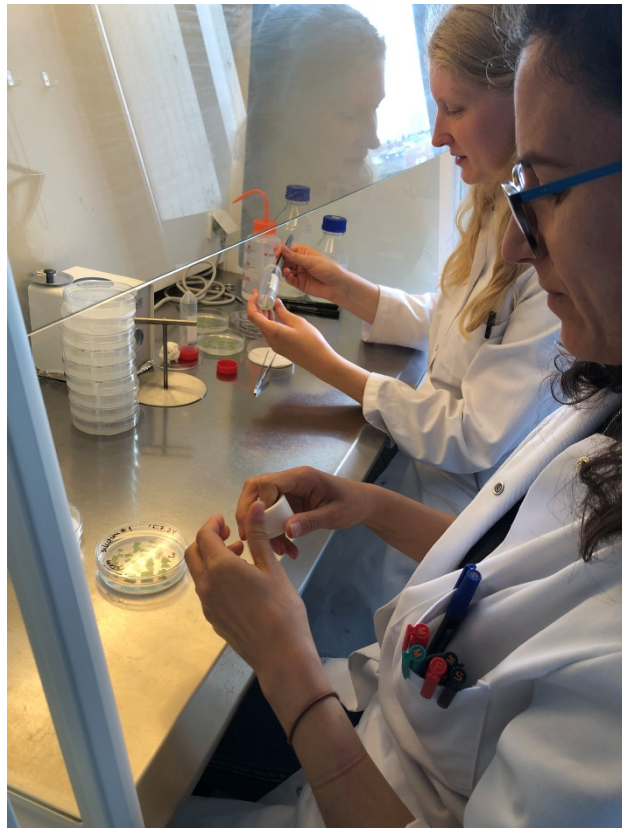
Scalable – for large-scale prioritization

Humanitarian demining

Support remote demining technologies



Plant Development UCPH



Selected Plants

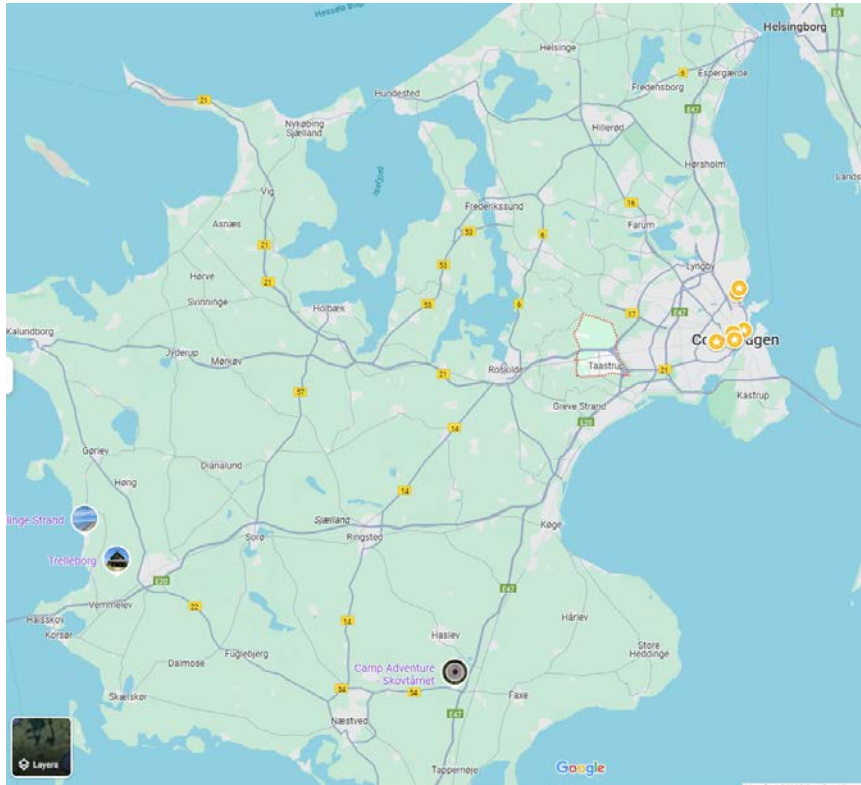


Winter rapeseed (*Brassica napus*)

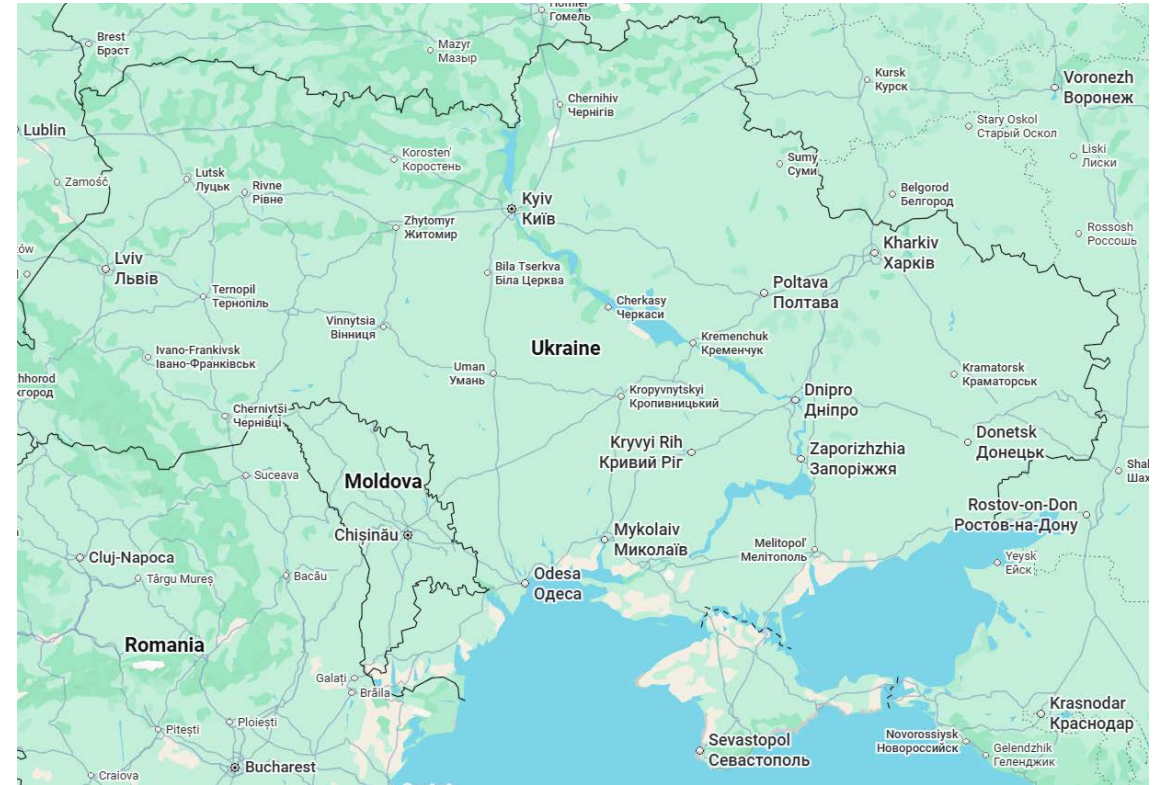


Oilseed radish (*Raphanus sativus* var *oleiformis*)

Field trials



- 1. Autumn 2024 Taastrup
- 2. Spring 2024 Taastrup
- 3. Spring 2025 Taastrup



- 1. Spring 2024 Kharkiv/Zhytomyr
- 2. Spring 2025 Kharkiv/Zhytomyr

Field Trial Example: Kharkiv

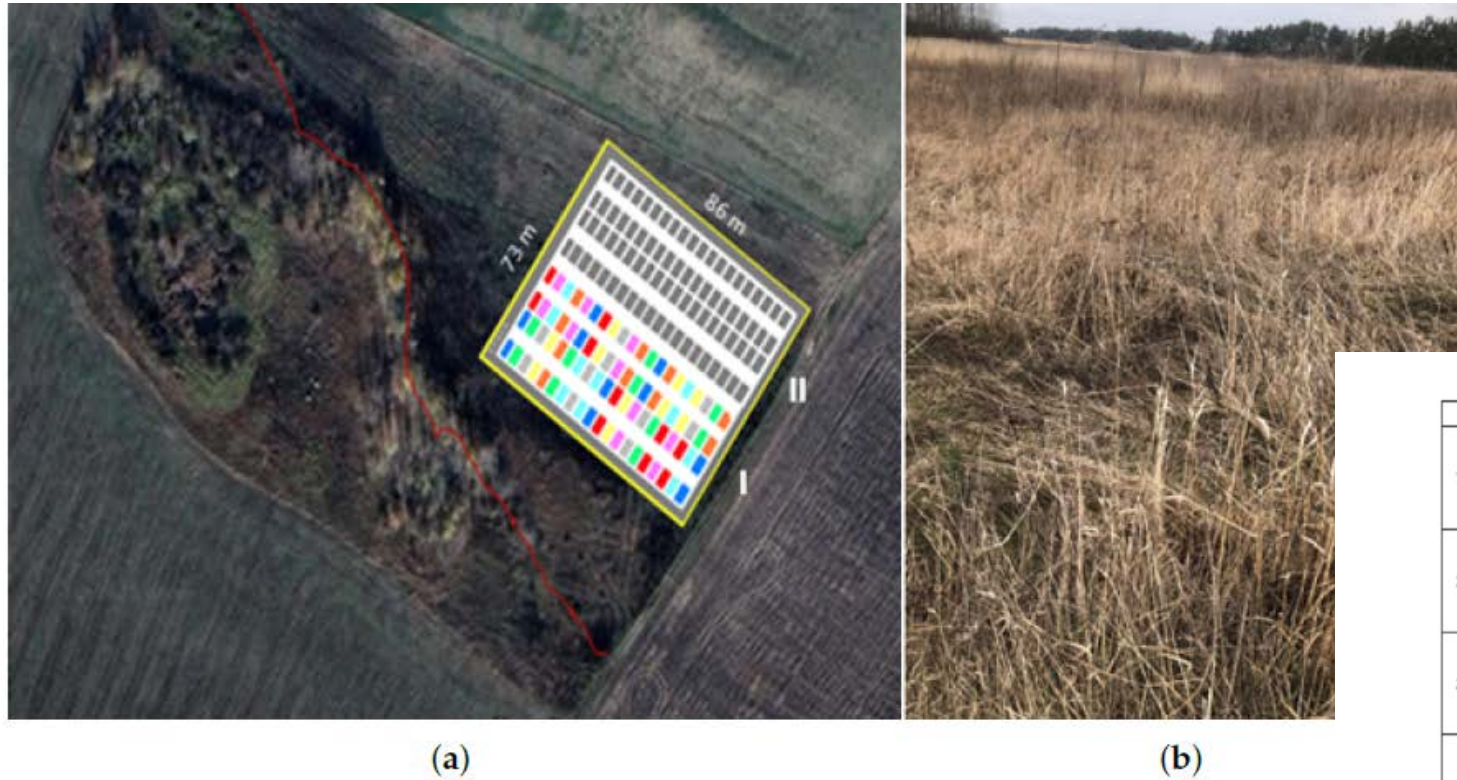


Figure 1. Experimental site in Seleksiynе village, Kharkiv region, Ukraine. (a) Schematic experimental plot overlaid on a satellite image. (b) View of the experimental site.

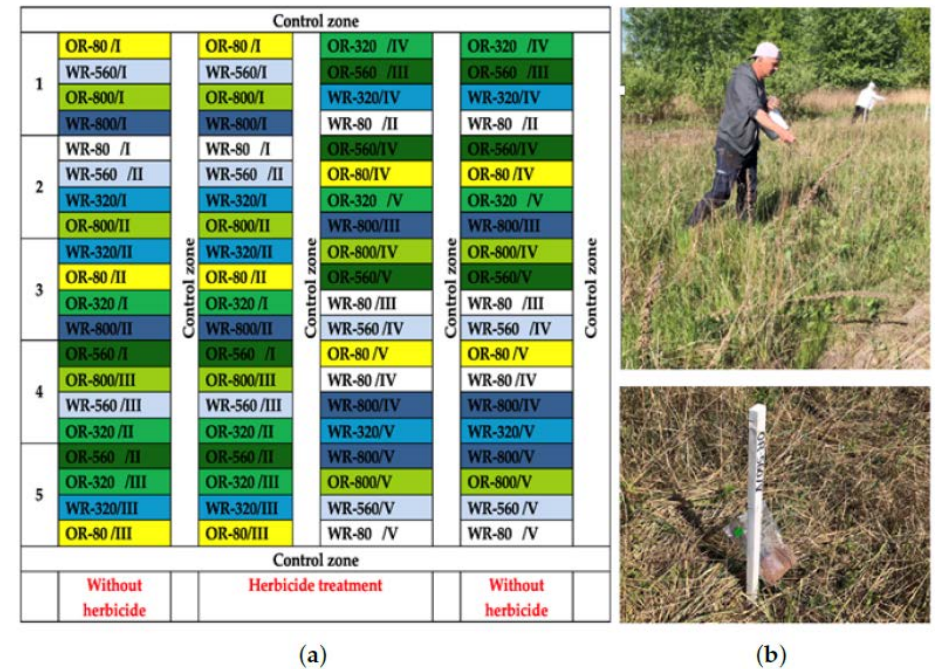
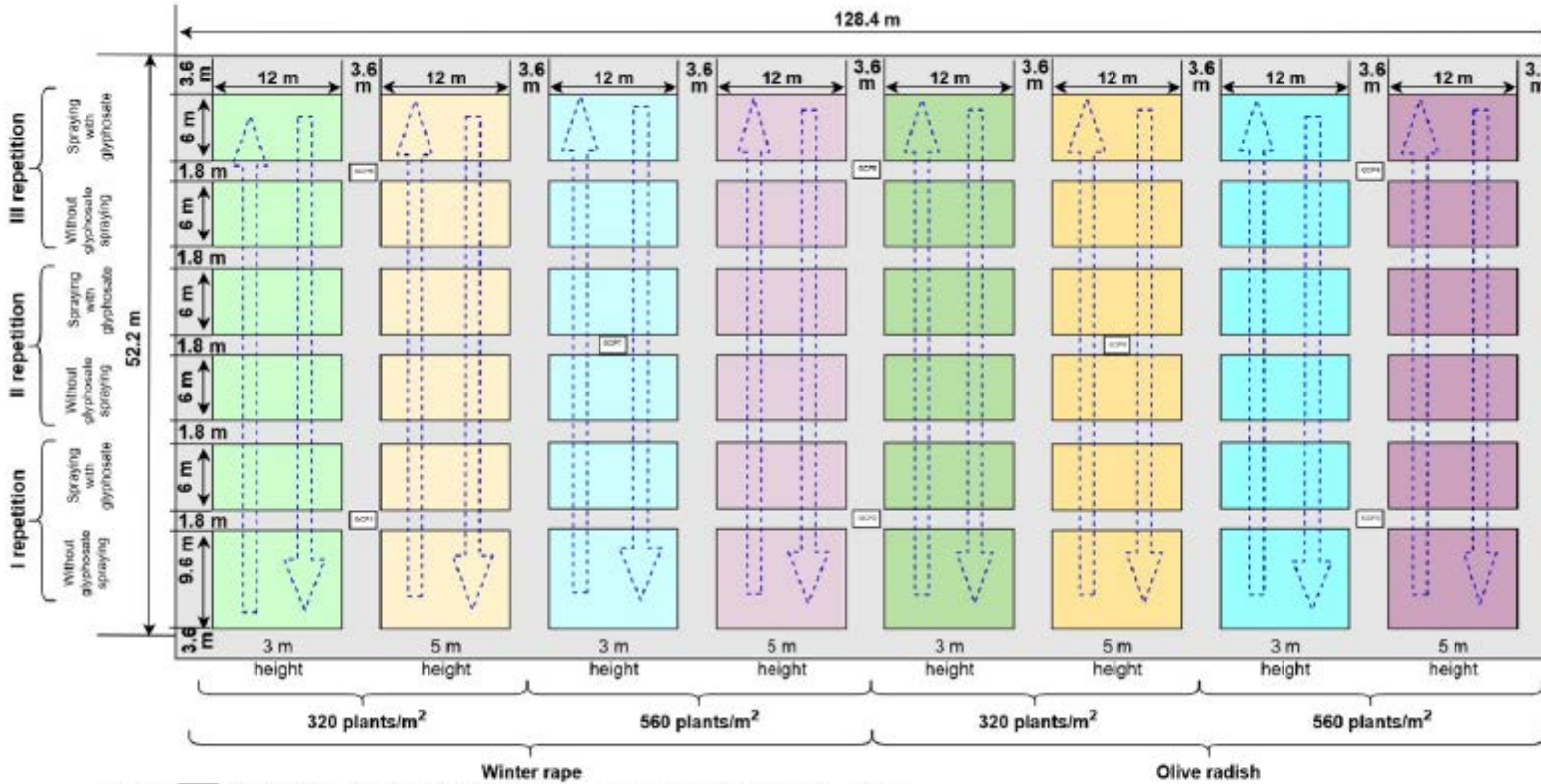


Figure 2. (a) Schematic diagram of winter rapeseed (WR) and oilseed radish (OR) sowing at different planting densities. (b) Example of manual sowing (5/03/2025).

Field Trial Example: Zhytomyr



Note: Protective strip (milled) between options - 1.8 m, between flight zones - 3.6 m.
 Elementary plot 6.0 m*12.0 m = 72.0 m²
 The area of the experimental plots (1 crop, 1 drone, 2 seeding rates, 2 heights) is 0.34 ha
 The total area (2 crops, 1 drone, 2 seeding rates, 2 heights) is 0.67 ha

Ddirection of movement of the drone during the mission

Ground control points



Field Trial Example: Taastrup

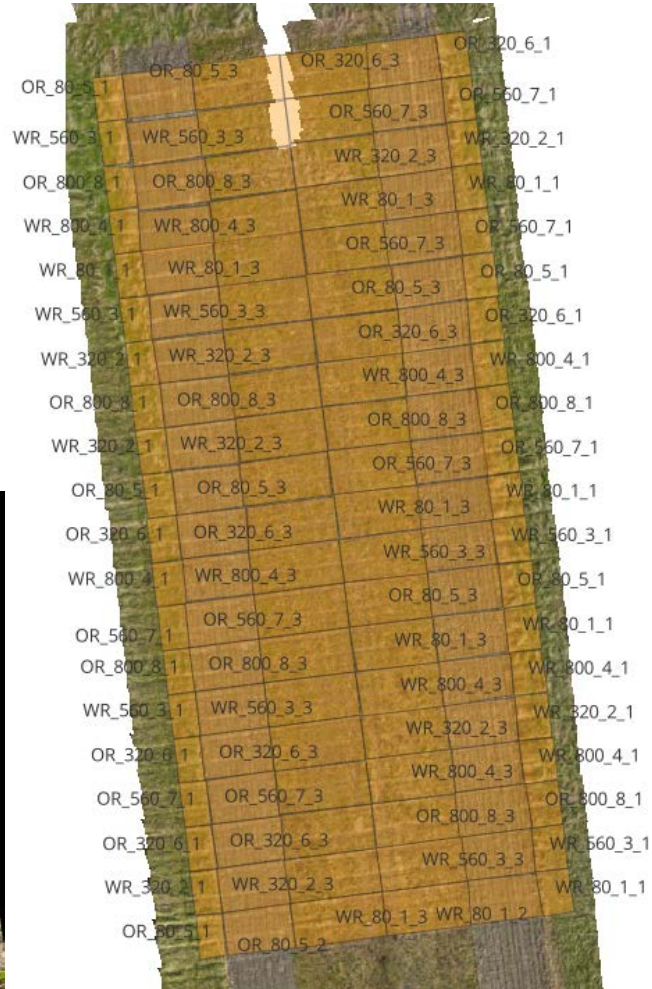
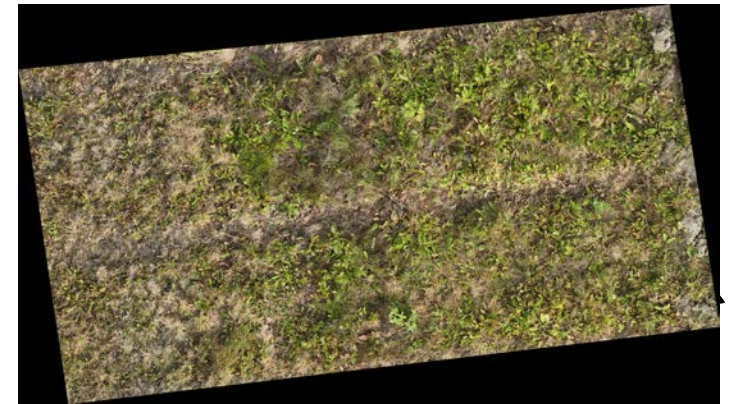
1. Control Field: This is the field that was not touched (left untreated)



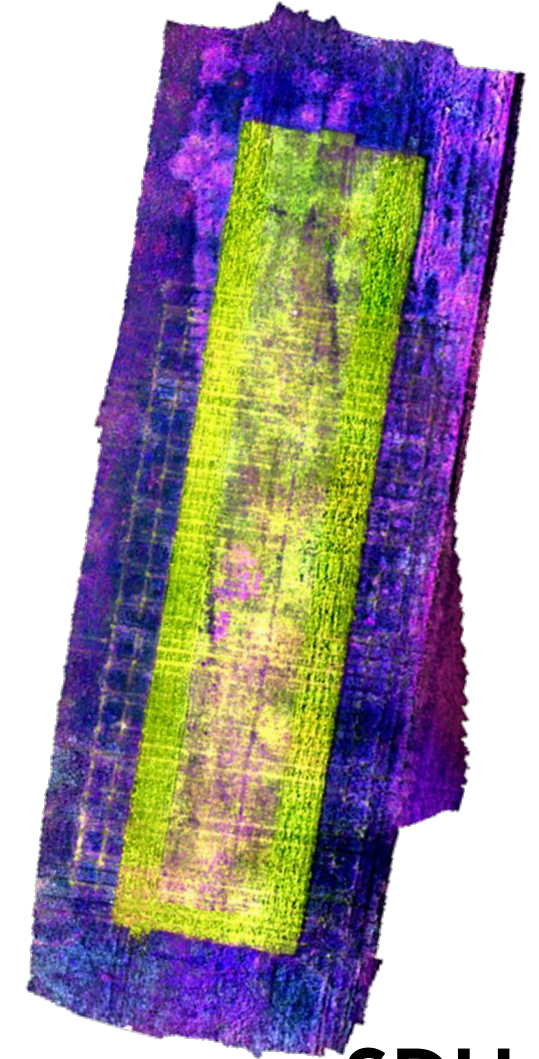
2. Tilled Field: This field has been tilled, meaning the soil has been turned over or prepared for planting.



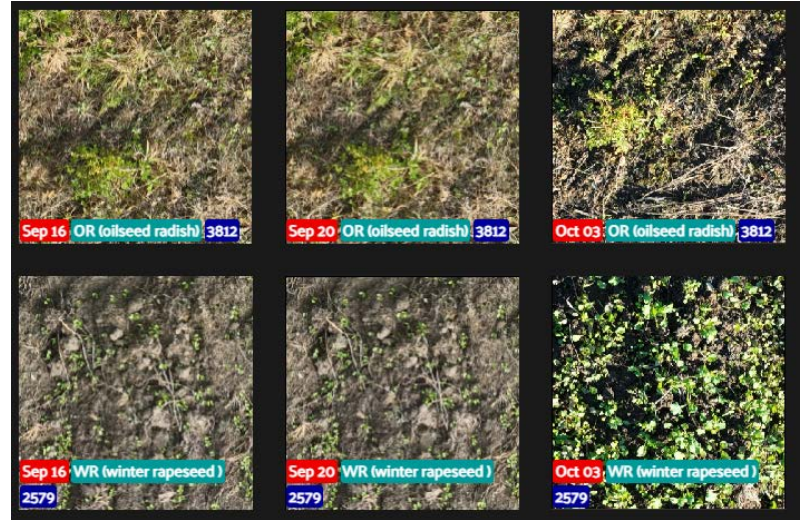
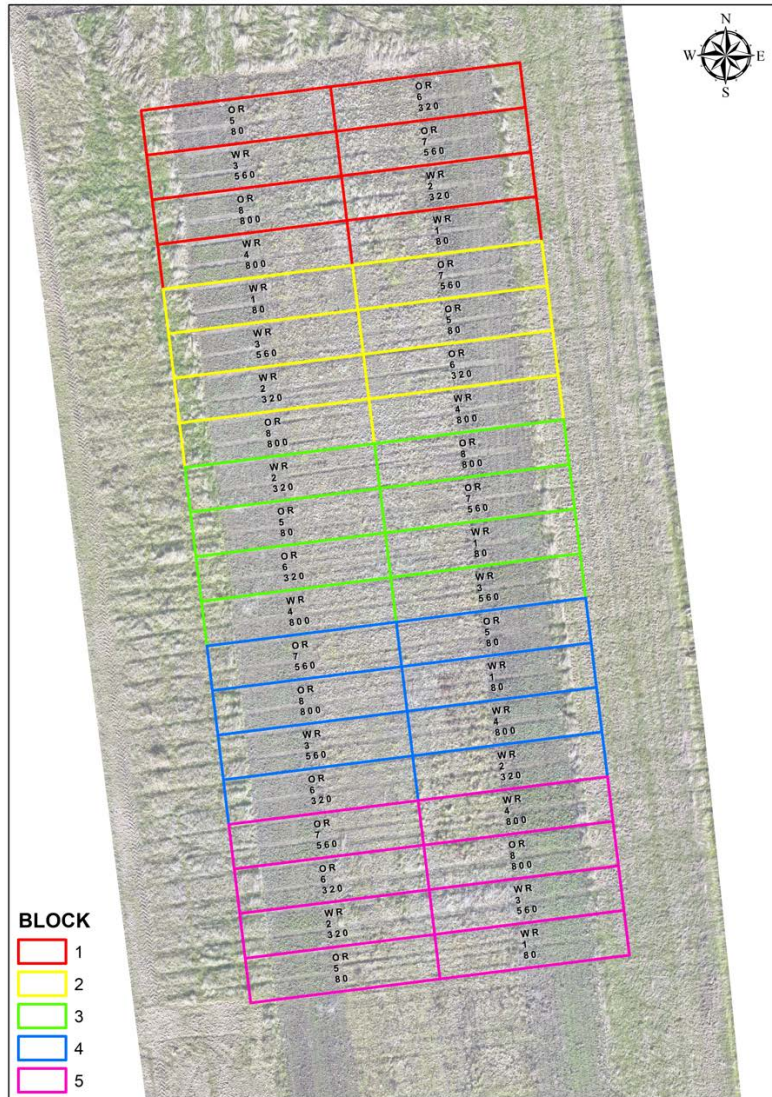
3. Sprayed Field: This field has been treated with weed-killing substances (herbicides).



Orthomosaics Created for All Experiments



Multiple Orthomosaics Generated per Trial



Challenges



Figure 10. Comparison of image resolution at 12 m (a) and 3 m (b) flight altitudes.

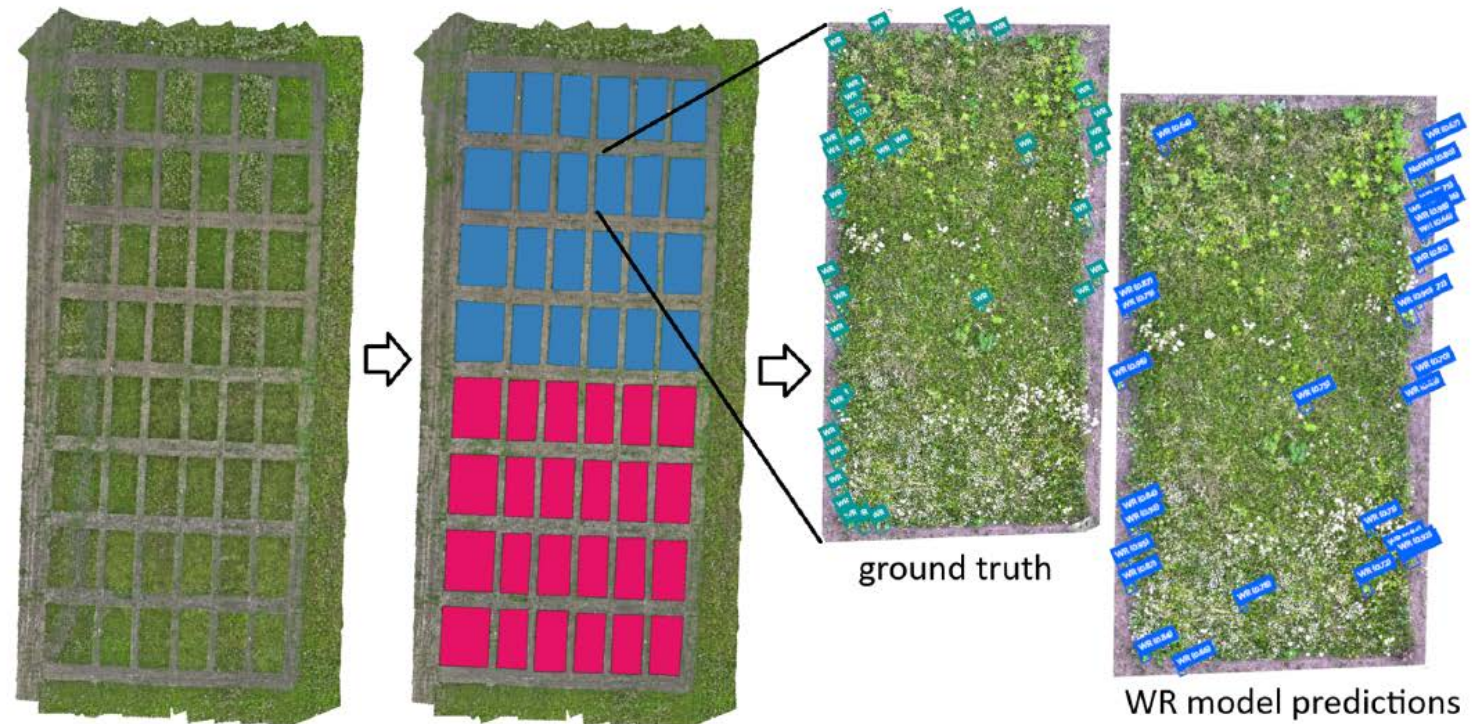
- Poor plant establishment in real fields, especially with broadcast seeding and no herbicide
- Environmental stressors such as drought, tall grasses, thistles, and slug damage reduce plant survival
- Species-specific limitations: winter rapeseed often fails; oilseed radish becomes obscured during blooming
- Insufficient spatial resolution at the operational altitude (12 m)
- Occlusion by weeds, shadows, and blooming structures makes visual detection harder

Results

Table 1. Detection performance across plant type, density, and glyphosate treatment.

Plant	Density	Glyphosate	Precision (%)	Recall (%)	F1 (%)
WR	320	+	42	25	31
WR	320	-	23	34	28
WR	560	+	49	26	34
WR	560	-	36	56	44
OR	320	+	62	29	39
OR	320	-	42	14	21
OR	560	+	86	28	42
OR	560	-	78	12	21

Note: "+" indicates glyphosate applied; "-" indicates no glyphosate. The highest scores are highlighted.



Conclusions

- UAV monitoring of indicator plants is feasible, but plant establishment is the main bottleneck—broadcast seeding without herbicide rarely produces detectable plants.
- Spatial resolution limits detection: 12 m flights lose ~94% detail vs. 3 m, making small plants hard to identify in real-field conditions.
- Herbicide-treated plots enable clear visibility, while untilled, weed-dominated areas severely reduce detectability.
- Oilseed radish establishes well but becomes obscured during blooming; winter rapeseed often fails under challenging conditions.
- Overall: a strong proof-of-concept that can be further strengthened with improved plant establishment, higher-resolution sensing, and optimized field/flight strategies.