# Site-specific mechanical weeding in North-West-Germany

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18th Congress of the European Society for Agronomy in Rennes, France

# INTRODUCTION

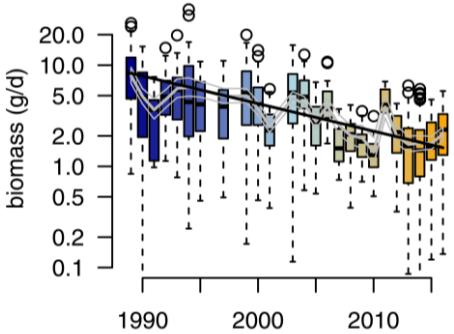
Weeds: **52 % yield losses** in maize

(Soltani et al., 2016)

Mechanical weeding:

- **Soil erosion**
- **Newly emerging weed**
- **Injured crop plants**

(Seitz et al., 2019; Woźniak, 2020)




**Insect biomass decline**

(Hallmann et al., 2017)

Weeds:

- **Habitat** for arthropods and birds
- **Soil cover**

(Bàrberi et al., 2010; Seitz et al., 2019)


Bàrberi, P., Burgio, G., Dinelli, G., Moonen, A.C., Otto, S., Vazzana, C., Zanin, G., 2010. Functional biodiversity in the agricultural landscape: Relationships between weeds and arthropod fauna. Weed Res. 50, 388–401. https://doi.org/10.1111/j.1365-3180.2010.00798.x

Hallmann, C.A., Sorg, M., Jongejans, E., Siepel, H., Hofland, N., Schwan, H., Stenmans, W., Müller, A., Sumser, H., Hörren, T., Goulson, D., De Kroon, H., 2017. More than 75 percent decline over 27 years in total flying insect biomass in protected areas. PLoS One 12. https://doi.org/10.1371/journal.pone.0185809

Seitz, S., Goebes, P., Puerta, V.L., Pereira, E.I.P., Wittwer, R., Six, J., van der Heijden, M.G.A., Scholten, T., 2019. Conservation tillage and organic farming reduce soil erosion. Agron. Sustain. Dev. 39. https://doi.org/10.1007/s13593-018-0545-z

Soltani, N., Dille, A.J., Burke, I.C., Everman, W.J., VanGessel, M.J., Davis, V.M., Sikkema, P.H., 2016. Potential corn yield losses due to weeds in North America. Weed Technol. 30, 979–984. https://doi.org/https://doi.org/10.1614/WT-D-16-00046.1

Woźniak, A., 2020. Mechanical and chemical weeding effects on the weed structure in durum wheat. Ital. J. Agron. 15, 102–108. https://doi.org/10.4081/ija.2020.1559

# INTRODUCTION


Weeds distributed uneven

(Pätzold et al., 2020)

- Influence of site-specific mechanical weeding on **maize yield**
- Influence of site-specific mechanical weeding on **weeds**
- Comparison between weed **control thresholds**

Pätzold, S., Hbirkou, C., Dicke, D., Gerhards, R., Welp, G., 2020. Linking weed patterns with soil properties: a long-term case study. Precis. Agric. 21, 569–588. https://doi.org/10.1007/s11119-019-09682-6

# TRIAL LOCATION AND TRIAL SETUP

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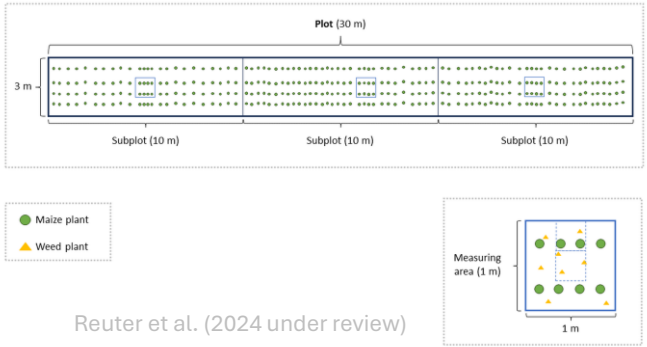
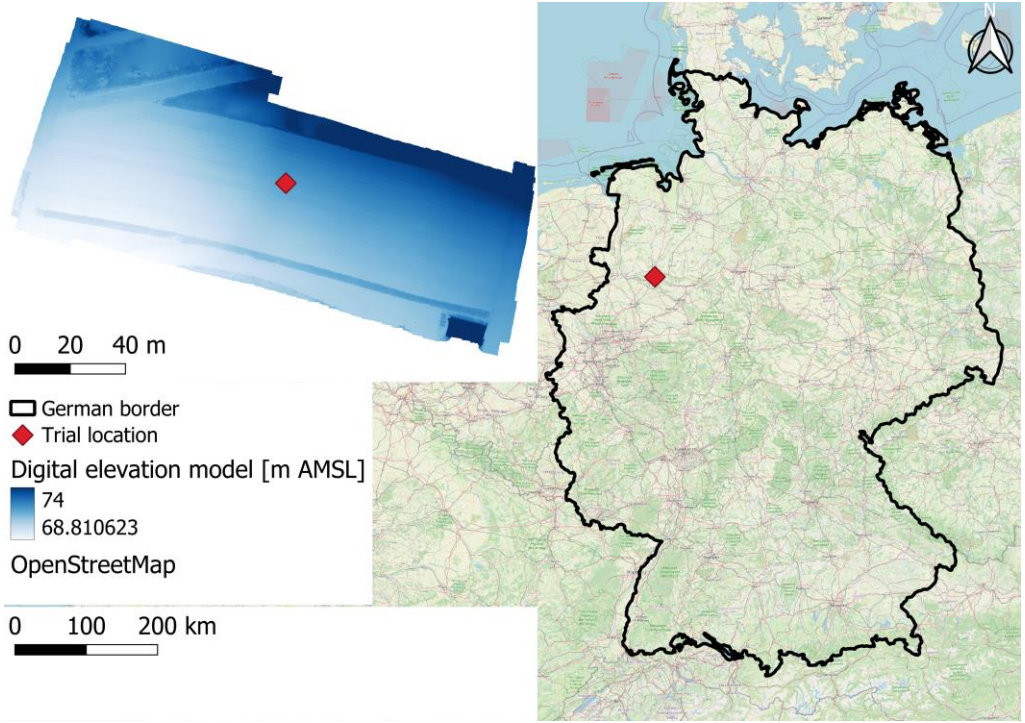
- Luvisol, Gleyic Cambisol

- 2021 and 2022
- Maize
- Mechanical weeding

- Randomized block design
  - Four repetitions
  - Three treatments




Reuter et al. (2024 under review)




Reuter, Tobias and Nahrstedt, Konstantin and Wittstruck, Lucas and Jarmer, Thomas and Broll, Gabriele and Trautz, Dieter, Site-Specific Mechanical Weed Management in Maize (Zea Mays): A Two Season Trial in North-West Germany. Available at SSRN: https://ssrn.com/abstract=4744762 or http://dx.doi.org/10.2139/ssrn.4744762

# TREATMENTS

- **Uniform weeding** as control (Con)

- Site-specific: **Weed Cover Threshold** (WCT)
  - 0.25 %
  - 0.50 %
  - 1.00 %

**Example WCT = 0.5 %**

Weed cover: 0.2 %

Weed cover: 0.5 %

- Site-specific: **Relative Weed Cover** (RWC, Ngouajio et al., 1999)
  - $= \frac{Weed\ cover\ (\%)}{Weed\ cover\ (\%) + Crop\ cover\ (\%)}$
  - With **bigger crop plants more weeds** can be **tolerated**.
  - 0.10
  - 0.20
  - 0.40

**Example RWC = 0.2**

Crop cover: 10 %
Weed cover: 5 %
RWC=0.33

Crop cover: 22 %
Weed cover: 5 %
RWC=0.18

Ngouajio, M., Lemieux, C., Leroux, G.D., 1999. Prediction of corn (Zea mays) yield loss from early observations of the relative leaf area and the relative leaf cover of weeds. Weed Sci. 47, 297–304. https://doi.org/10.1017/s0043174500091803

# WEED RECOGNITION



- **Multispectral images:** red, green, blue, near infrared
- **Pixel resolution: 4 – 10 mm**
- **Flight altitude: 10/25 m**

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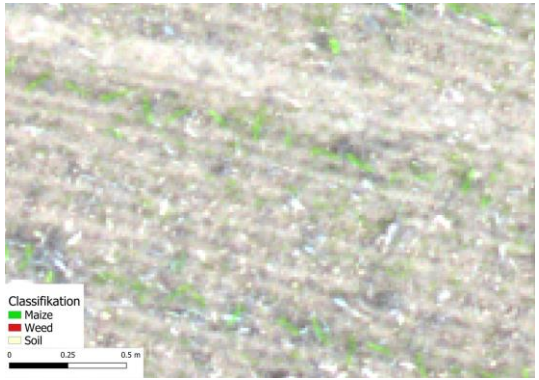
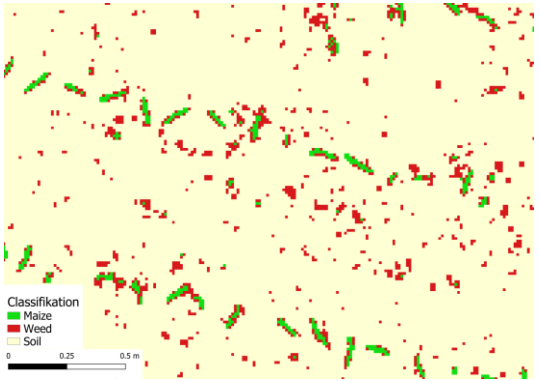
- **Convolutional Neural Network/Random Forest**
  - Three classes:
    - **Bare soil**
    - **Maize**
    - **Weeds**
  - Overall accuracy: **85 % – 92 %**



# WEATHER CONDITIONS AND WEED REGULATION

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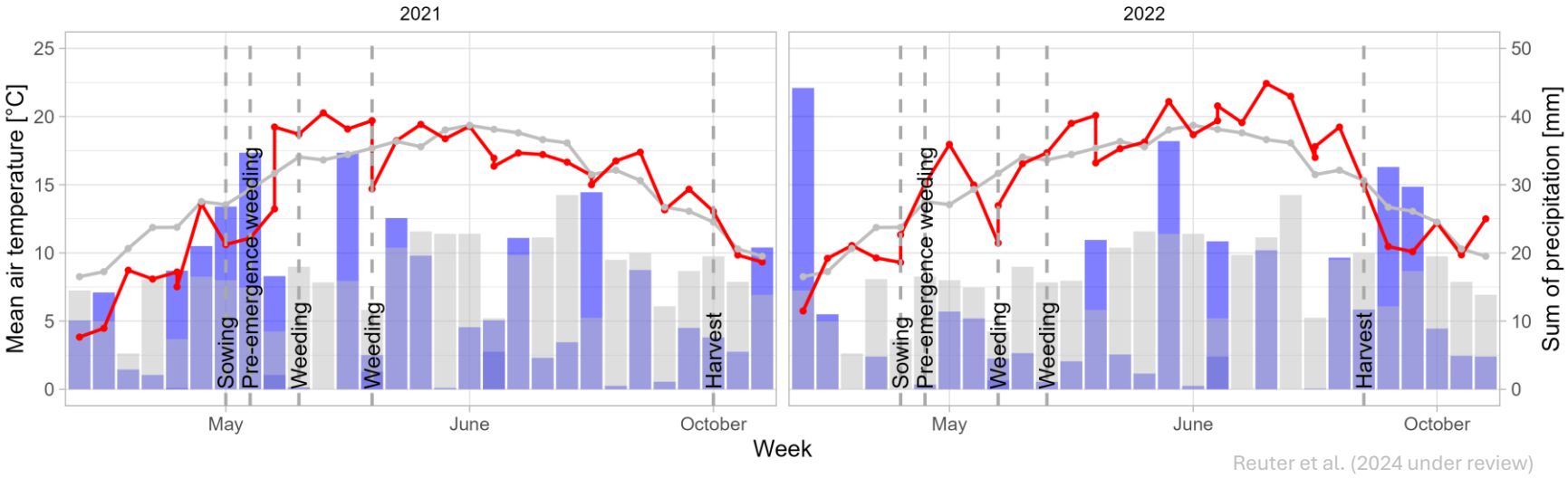


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V5: uniform

V13: Uniform/site-specific

V15: Uniform/site-specific


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# WEED REGULATION

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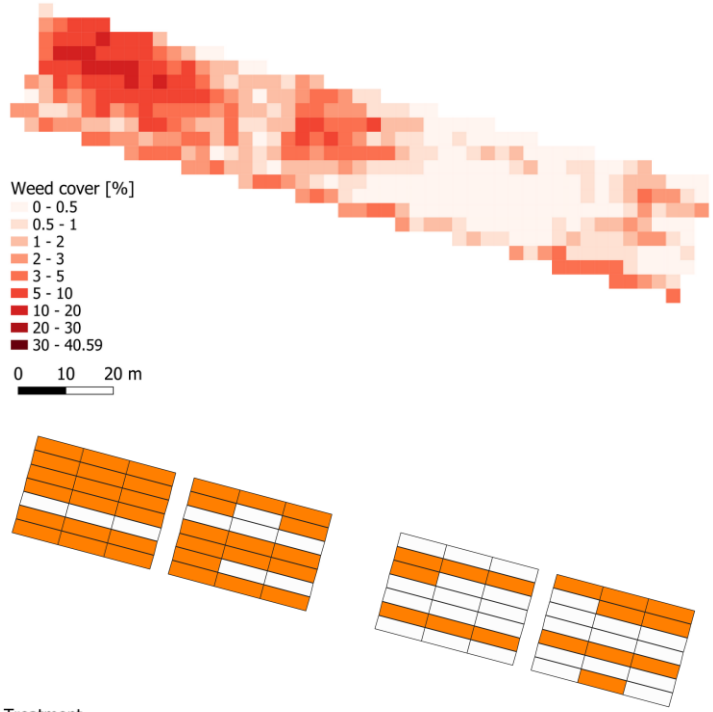
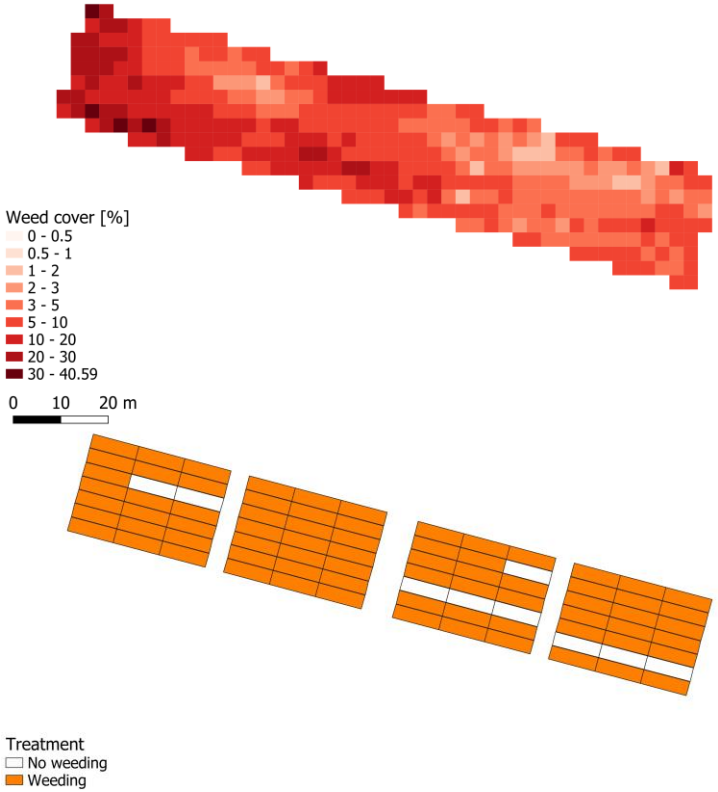
## 2021




## 2022



# MAIZE YIELD AND WEED BIOMASS

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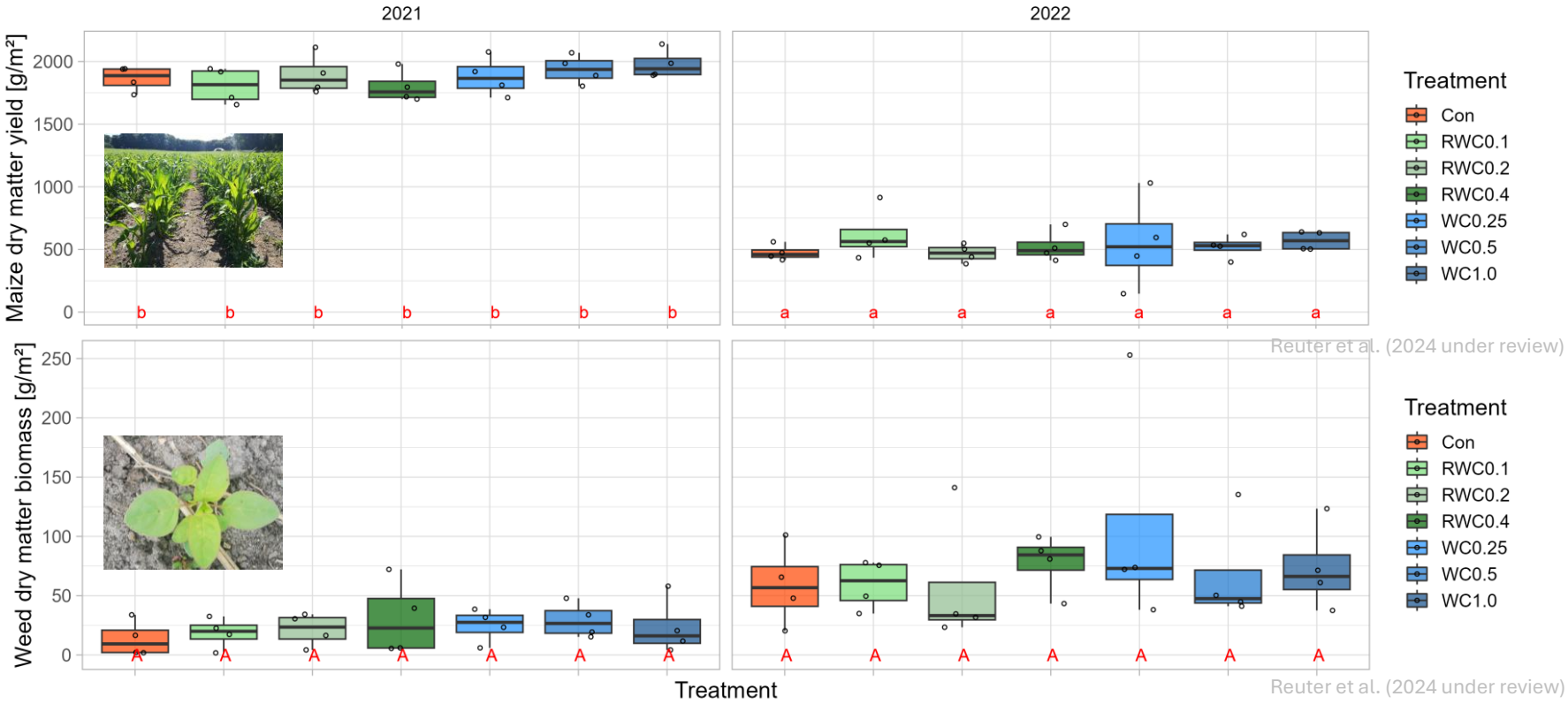


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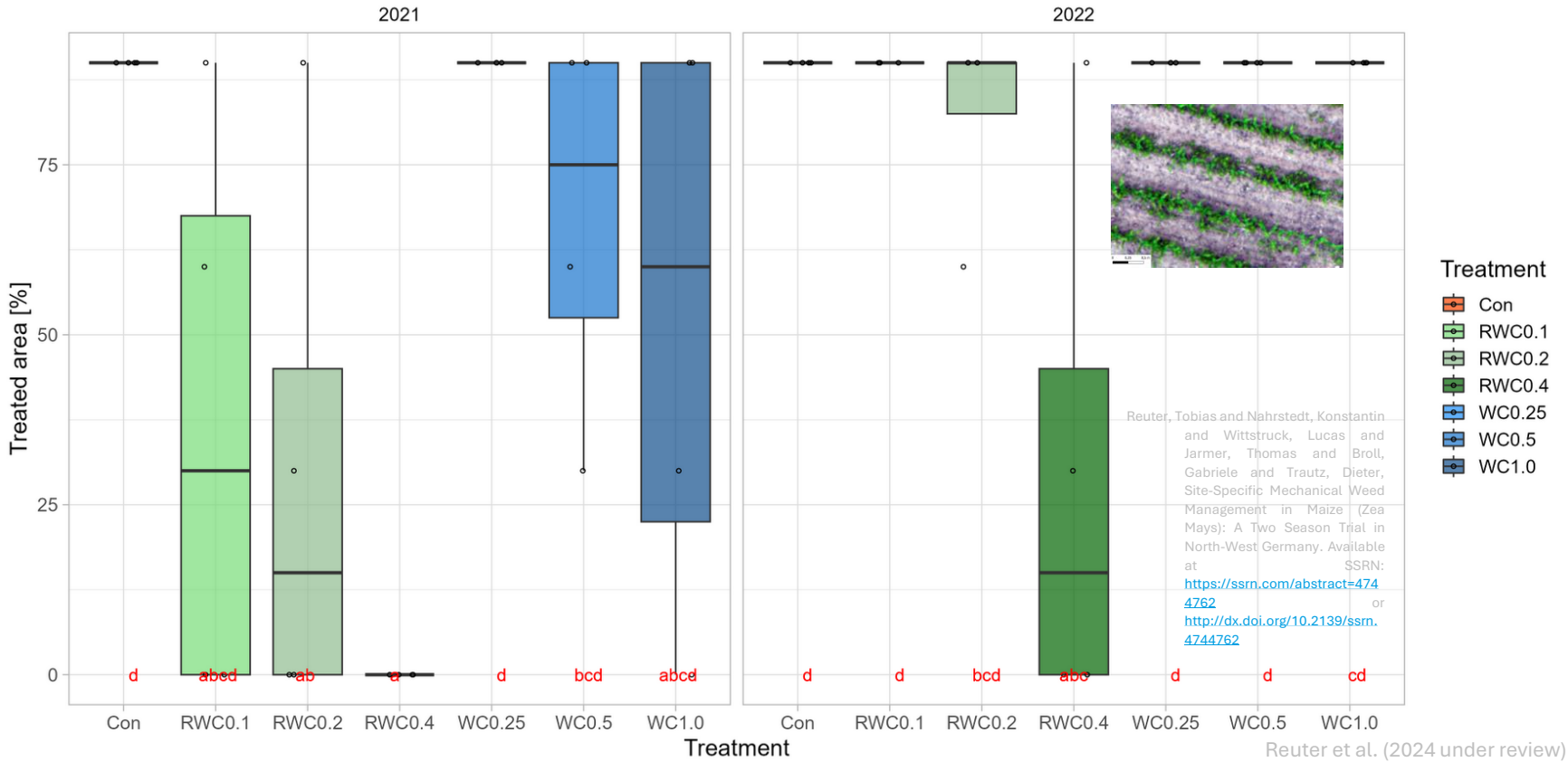
Difference letters indicates significant differences (TUKEY, p<0.05)

# TREATED AREA

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# DISCUSSION

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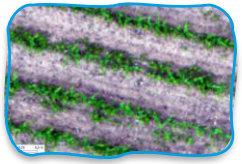
**No yield differences**
between treatments



Site-specific weed management
→ **less treated area**

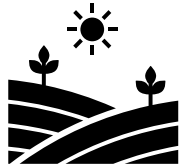
**UAV** is **useful** for
weed recognition

Side-specific weed
management → **no influence on weeds**

**Relative weed cover**
beneficial

**Long term effect**

**Time** between flight
and application ↓



**Threshold optimizing**
by site and crop

Gefördert durch:
Bundesministerium für Ernährung und Landwirtschaft
aufgrund eines Beschlusses des Deutschen Bundestages
ptble
Funding: 28DE103B18 and 28DE103C18

EXPERIMENTIERFELD AGRO-NORDWEST

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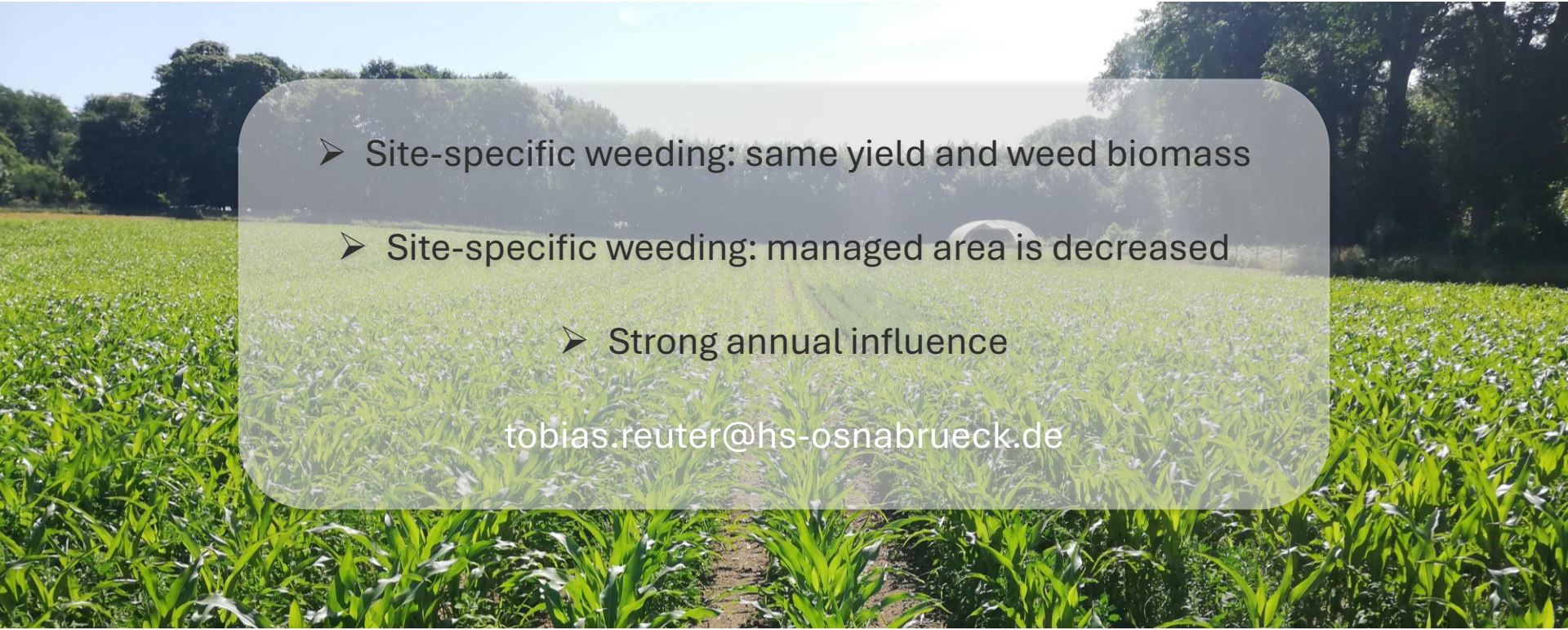

- Site-specific weeding: same yield and weed biomass
- Site-specific weeding: managed area is decreased
- Strong annual influence

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# CLASSIFICATION RESULTS

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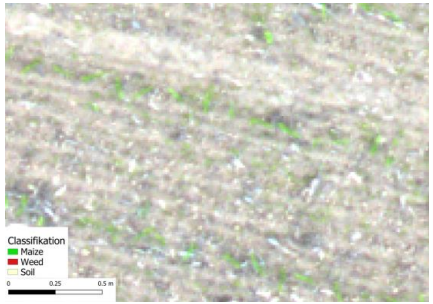
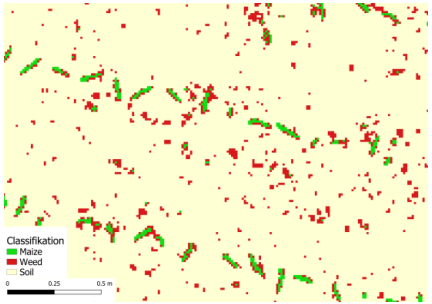
| Timestamp of acquisition | Camera system | F1-score (in %) | | | OA (in %) | Machine learning methods |
|---|---|---|---|---|---|---|
| | | Maize | Weeds | Soil | | |
| 3rd July 2021 | MicaSense Altum | 81.6 | 86.1 | 87.9 | 85.1 | Convolutional neural network |
| 17th July 2021 | MicaSense Altum | 85.2 | 87.0 | 87.9 | 86.7 | Convolutional neural network |
| 19th May 2022 | MicaSense Altum | 85.6 | 82.3 | 98.3 | 88.8 | Random forest |
| 10th June 2022 | Phantom MS | 88.4 | 88.3 | 99.3 | 92.0 | Random forest |

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# MAIZE PLANT HEIGHT AND WEED COVER

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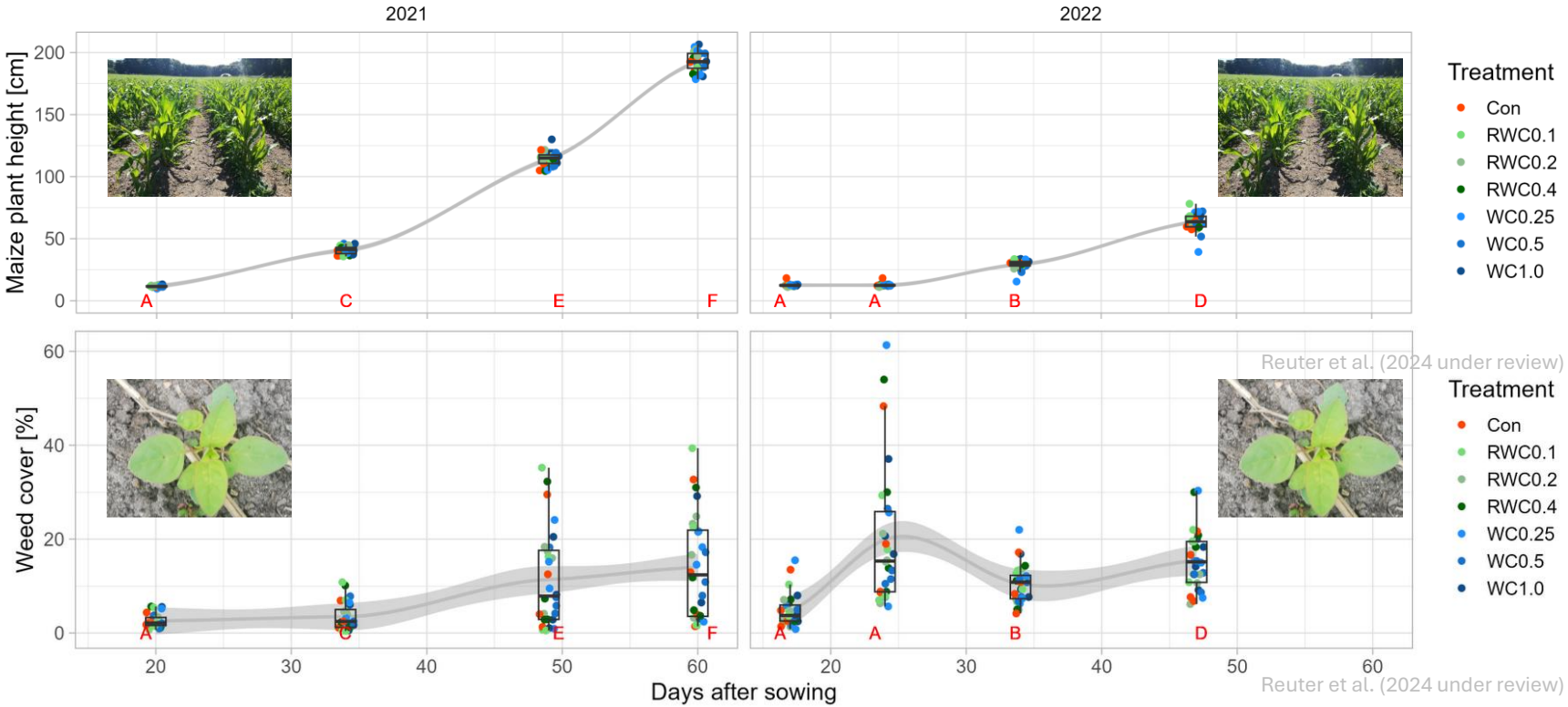


Reuter et al. (2024 under review)

Reuter et al. (2024 under review)

No differences between treatments (ANOVA, p>0.05)

Difference letters indicates significant differences (TUKEY, p<0.05)

Reuter, Tobias and Nahrstedt, Konstantin and Wittstruck, Lucas and Jarmer, Thomas and Broll, Gabriele and Trautz, Dieter, Site-Specific Mechanical Weed Management in Maize (Zea Mays): A Two Season Trial in North-West Germany. Available at SSRN: https://ssrn.com/abstract=4744762 or http://dx.doi.org/10.2139/ssrn.4744762

# WEED SPECIES

- *Chenopodium album* with 196 (2021) to 576 (2022) counts
- *Stellaria media* (150/144 counts)
- *Poa trivialis* (141/113 counts)
- *Polygonum convolvulus* (138 in 2022 and only 44 in 2021).
- *Galinsoga ciliate* were found 43 to 70 times
- *Amarathus Capsella bursa-pastoris*
- *Echinochloa crus-galli L.*
- *Equisetum arvense*
- *Lamium purpureum,*
- *Spergula arvensis*
- *Veronica agrestis L.*