EVALUATION OF THE EFFECT OF DIFFERENT HERBICIDE TREATMENTS BY USING UAV IN MAISE (ZEA MAYS L.) CULTIVATION – FIRST EXPERIENCES IN A LONG-TERM EXPERIMENT AT SZÉCHENYI ISTVÁN UNIVERSITY, HUNGARY

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Abstract.

The EU aims to reduce chemical pesticide use by 50% by 2030. To achieve this, it's crucial to monitor the temporal and spatial effects of pesticides on weeds in various crops. Syngenta Ltd., in collaboration with researchers, plans to use UAVs to monitor the impact of five herbicides in two tillage treatments (Conventional and Conservation) during maise production. The research was conducted in a 1.5-hectare agricultural field in Mosonmagyaróvár, Győr-Moson-Sopron County, Hungary. Maise was grown in the research field in 2023 with a plant population of 70.000 per hectare in CN (medium-depth ploughing up to 27 cm) and CR (ultra-shallow tillage by disc up to 4-6 cm) tillage systems. Four different doses of UREA (46%): 0 kg N/ha, 160 kg N/ha, 320 kg N/ha, 480 kg N/ha; and five different types of herbicides with different application timing (1 – Elumis Bang treatment one-shot spray, 2 – Elumis split application in 2 splits, 3 – PeakNik treatment one-shot spray, 4 – Control post, 5 – Control e-post) were applied. The effectiveness of the different herbicides was monitored by DJI Phantom 4, which was mounted with a multispectral camera. Remote sensing data collection started at the first herbicide application and finished 15 days after the last treatment. NDVI index was calculated from UAV imagery to monitor the weed flora within the blocks. The flight height was 35 meters. The front and side overlaps were both set to 70%. The images were processed with Agisoft Metashape (version 2.0.1) and QGIS (version 3.22). The weed vegetation of each plot was surveyed manually in three repetitions at 14 days after the last treatments. Two-way ANOVA evaluated the data with post-hoc Tukey HSD at a significance level of $p \leq 0.05$. The Elumis Bang treatment showed the highest efficiency in both tillage systems. In the CN tillage system, the second most effective treatment was Control Post, and the third most effective treatment was PeakNik. In contrast, in the CR tillage system, the second most effective treatment was PeakNik, followed by the Control post-treatment. Observations indicate that UAVs can effectively monitor herbicide treatments' temporal and spatial effects, reducing the labour needed for field weed surveys.

Keywords.
herbicide treatments, different tillage systems, Syngenta Ltd., UAV

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Introduction

As per the EU Green Deal, the effectiveness of herbicides plays a crucial role in sustainable agriculture, especially in integrated weed management strategies that aim to minimise environmental impacts and reduce chemical inputs (Tataridas et al., 2022, Triantafyllidis et al., 2023). Understanding the temporal and spatial dynamics of herbicide applications is necessary to maximise their effectiveness and reduce the need for labour-intensive field surveys (Talavia et al., 2020; Gerhard et al., 2022). Recent innovations, such as unmanned aerial vehicles (UAVs), provide innovative methods for accurately dousing herbicides and tracking their effectiveness in real-time, enhancing the precision of weed control strategies (Waqas et al., 2023; Zhang et al., 2024). This study makes an effort to evaluate the effectiveness of various herbicide treatments under varied nitrogen dosages and tillage systems using UAV technology.

Materials and methods

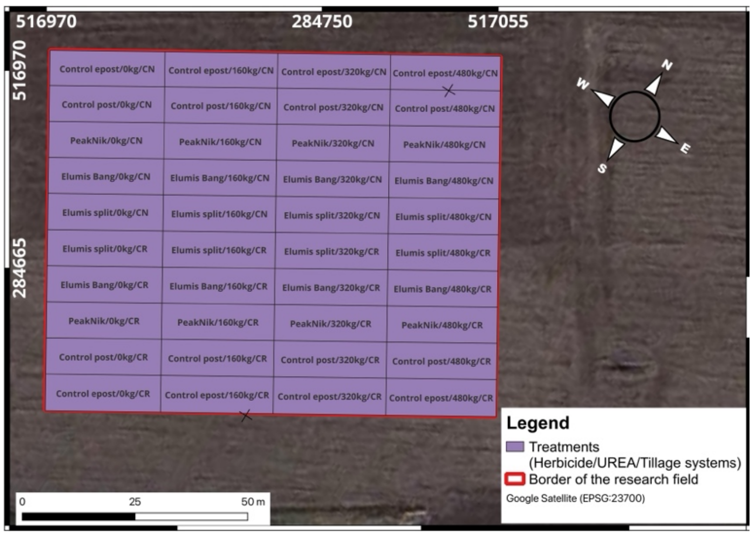

Figure 1. Location of the research field

The research was conducted in a 1.5-hectare field in typical agricultural land in Mosonmagyaróvár, Győr-Moson-Sopron County, Hungary. Maise (*Zea mays* L.) was grown in the research field in 2023 with a plant population of 70.000 per hectare in CN (medium-depth ploughing up to 27 cm) and CR (ultra-shallow tillage by disc up to 4-6 cm) tillage systems. Four different doses of UREA (46%): 0 kg N/ha, 160 kg N/ha, 320 kg N/ha, 480 kg N/ha; and five different types of herbicides with different application timing (1 – Elumis Bang treatment one-shot spray, 2 – Elumis split application in two splits, 3 – PeakNik treatment one-shot spray, 4 – Control post, 5 – Control e-post) were applied (Figure 1. and Table 1.). The effectiveness of the different herbicides was monitored by DJI Phantom 4, which was mounted with a multispectral camera. Remote sensing data collection started at the first herbicide application and finished 15 days after the last treatment. NDVI index was calculated ((NIR – RED)/(NIR + RED)) from UAV imagery to monitor the weed flora within the blocks at the pre-defined points. The flight height was 35 meters. The front and side overlaps were both set to 70%. The images were processed with Agisoft Metashape (version 2.0.1) and QGIS (version 3.22). The weed vegetation of each plot was surveyed manually in three repetitions at 14 days after the last treatments. Two-way ANOVA evaluated the data with post-hoc Tukey HSD at a significance level of p≤0.05.

Table 1. Herbicide treatments

Nr. of treatments	ID of treatments	Dose rates	Application time
1.	Elumis Bang treatment one shoot spray:	Elumis (2 liter/ha) + Banvel (0.6 liter/ha) + FixPro (0.1 liter/ha)	**Crop stage:** Broad-leaved weeds have 2-4 leaves; grass weeds have 3-5 leaves. At the latest, maize has 6 leaves.
2.	Elumis split application in 2 splits: 1st treatment (1st split)	Elumis (1.3 liter/ha) + FixPro (0.1 liter/ha)	**Crop stage:** Broad-leaved weeds have 2-4 leaves; grass weeds have 3-5 leaves. At the latest, maize has 6 leaves.
	2nd treatment (2nd split)	Elumis (0.7 liter/ha) + FixPro (0.1 liter/ha)	**Crop stage:** Maise is at max 6 leaves stage
3.	PeakNik treatment one shoot spray	Milagro Plus (1.2 liter/ha) + Peak (20 gram/ha) + Eucarol Plus (0.5 liter/ha)	**Crop stage:** Broad-leaved weeds have 2-4 leaves, grass weeds have 3-5 leaves, and maise has 6 leaves at the latest.
4.	Control post	Laudis (2 liter/ha)	**Crop stage:** Broad-leaved weeds have 2-4 leaves, grass weeds have 3-5 leaves, and corn has six leaves at the latest.
5.	Control epost	Successor solo (2 liter/ha) + Callisto 100 (1 liter/ha) + Peak (20 gram/ha) + FixPro (0.1 liter/ha)	**Crop stage:** Grass weeds have 1-3 leaves

Results

Based on the results, the Elumis Bang treatment was the most effective for geolocated weeds in both the CN and CR tillage systems after 19 days of herbicide treatment (19/06/2023). In the CN tillage system, the second most effective treatment was Control Post, and the third most effective treatment was PeakNik. In contrast, in the CR tillage system, the second most effective treatment was PeakNik, followed by the Control post-treatment (Figure 2.). After 19/06/2023, an increase in the NDVI index can be observed due to leaf closure.

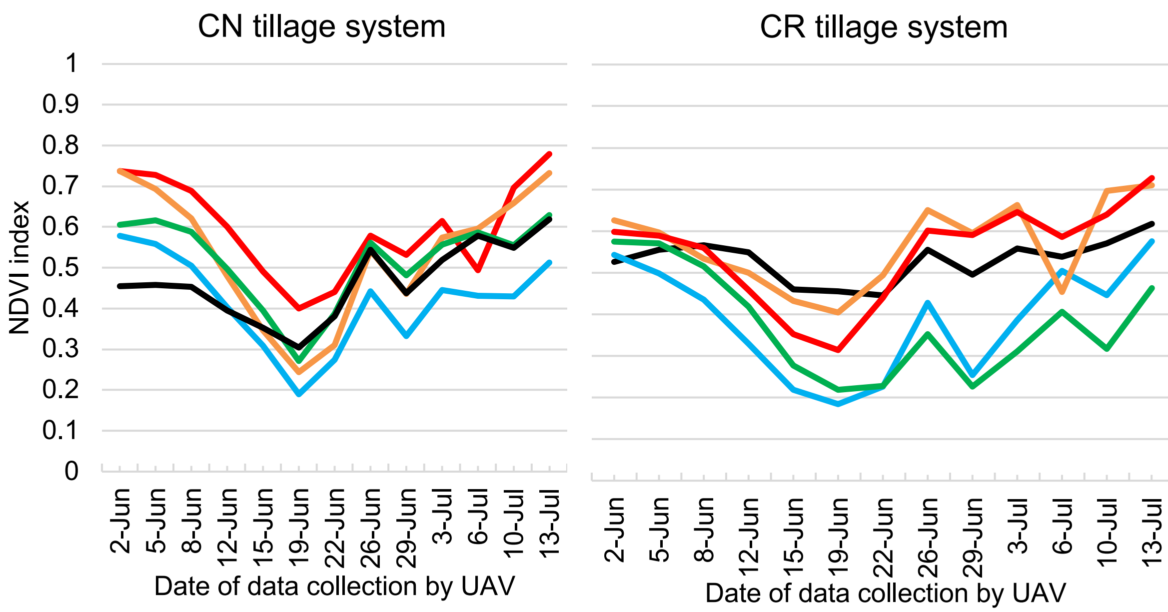

Figure 2. NDVI trend of geolocated weeds in different tillage systems and herbicide treatments

Red= Control epost; Blue=Elumis Bang; Black=Elumis split; Green=PeakNik Brown=Control post

Discussion and conclusions

The integrated weed control frameworks aim at decreasing environmental impacts while the effectiveness of chemical consumption increases (Tataridas et al., 2022; Triantafyllidis et al., 2023). This study assessed the effectiveness of several herbicide treatments in maise over a range of nitrogen dosages and tillage regimes in Mosonmagyaróvár, Hungary. The best herbicide for both CN (medium-depth ploughing) and CR (ultra-shallow tillage) systems, according to the results, was Elumis Bang. The second and third most successful treatments varied depending on the tillage technique, underscoring the significance of adjusting herbicide application to particular farming techniques. These results highlight how UAV technology can contribute to monitoring the efficiency and precision of herbicide administration, supporting the objectives of sustainable agriculture. Future research should concentrate on the long-term effects and deeper integration of UAVs with other precision agriculture instruments to maximise productivity and sustainability.

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