COMBINING UAV-BASED ZONE SPRAYING AND VRA TECHNOLOGY TO ACHIEVE A 50% CHEMICAL DECREASE FOR EU'S GREEN DEAL

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Abstract

Agricultural-origined polluting is one of the greatest problems of humanity nowadays, as great as producing food for every people in the world. We wanted to prove the relevance of new UAV based technologies in agriculture, and their efficiency in the decreasement possibilities in chemical usage. Our research shows that the European Green Deal could be accessible (or available) with precision farming combined with drone technologies.

Introduction

Agriculture is one of the most polluting areas of human activity, because of using fertilizers, insecticides, pesticides and herbicides. However, almost 8 billion people have to eat. Humanity has just one possibility to solve the problems of 21th century: with new technologies. If we want to achieve the agricultural chemical decrease goals of the European Green Deal by the year 2030 (50%), we have to develop and use new technologies, for example agricultural drones in pest and noxious weed control. Advantages of drones (UAV) are the following: no treading, no compression and most importantly approximately -30% need of chemical dosage can be achieved (diploma thesis, in press)! Using agricultural drones is legal and widespread in many countries of the world, but in Hungary only the experimental use is accepted yet. Cirsium arvense and other „injurious weeds" are causing problems in certain regions of the world (Europe, Canada, New Zealand etc.). Cirsium arvense is an erect perennial rhizomatous thistle. It is usually 0.5 - 1.0 m tall, distinguished from all other thistles by dense clonal growth, creeping horizontal lateral roots and male and female flowers are on separate plants. Cirsium leaves glabrous below with many marginal spines.[1] The traditional method of chemical weed contol (for perennial weeds like Cirsium arvense, Convulvulus arvensis, Asclepias syriaca…) is a „blanket application" on the field with glyphosate (or other total herbicide) by tractor with 5 l/ha dosage in solution 300 l/ha (with 4 l/ha Nitrosol (Liquid nitrogen (30%) fertilizer) and 0,01% Trend 90), which means the whole parcel plot is being sprayed, no matter if there is any weed or not.

Our research is closely related to the trend of the European Union: experimenting necessary doses of the allowed chemicals to the new treatment technologies for drones. In this research we were focusing on Cirsium arvense, a geophyton weed which has an overwinter body in the soil, so defence is very difficult against it. The best way to eliminate geophytons is the treatment with absorbed chemicals, such as glyphosate, in autumn or spring before seeding.[2]

Experimental

An 18 ha field was treated with herbicide (near an untreated control field), the previous crop was cereal. Glyphosate (N-Phosphonomethyl-glycine) products are one of the most widely used weed killers worldwide in farms and in home gardens, it is used in 1600 t/year in Hungary. It's licence will expire in 2025 December, but there are no other alternative herbicides yet. DJI Phantom 4 Multispectral (P4M) drone was used for orthoimagery. This drone has a head sensor with 6 cameras (Red, Green, Blue, RedEdge, NIR, RGB) and a built-in sunlight sensor for accurate results. The flights and the routes can be planned, and operated by the DJI GS Pro Ipad

app for drone operations (free software, https://apps.apple.com/us/app/dji-gs-pro/id1183717144). DJI TERRA software was used for analyzing, processing, visualizing, and planning spraying works for the AGRAS agricultural drones. DJI AGRAS T20 agricultural drone (container volume 20 liters, route width 6 meters on 2,5-3m route altitude) was applied for the spraying of herbicide.
The experiment was planned for a 18 ha treated parcel and an untreated, control parcel. If we had used the traditional method we would have needed 18 ha x 5 l/ha = 90 l of glyphosate. Earlier experiments showed that the traditional spraying with tractor has approximately 40-60% solution waste (on the ground). Spraying with drones also have waste, but significantly less than the traditional way (10%, in press). Our main goal was to achieve the minimal possible environmental impact with the appropriate herbicide effect.
In the experiment, our zone spraying method was combined with DJI's Various Rate Application (VRA) technology, which is based on the NDVI values collected by the P4M. The resolution of the generated prescription map for VRA was 6x6 meters.
Three different dosages of glyphosate solution were sprayed, depending on the infection rate of the weed spots (weak, moderate and strong infection). 8 l/ha solution was sprayed to the weakly infected areas (NDVI ≤ 0,1), 10 l/ha to the moderately infected areas (0,1 < NDVI < 0,2), and 12 l/ha solution was applied to the strongly infected parts (NDVI ≥ 0,2). The base solution was 10 l/ha containing 3,5 l of glyphosate.

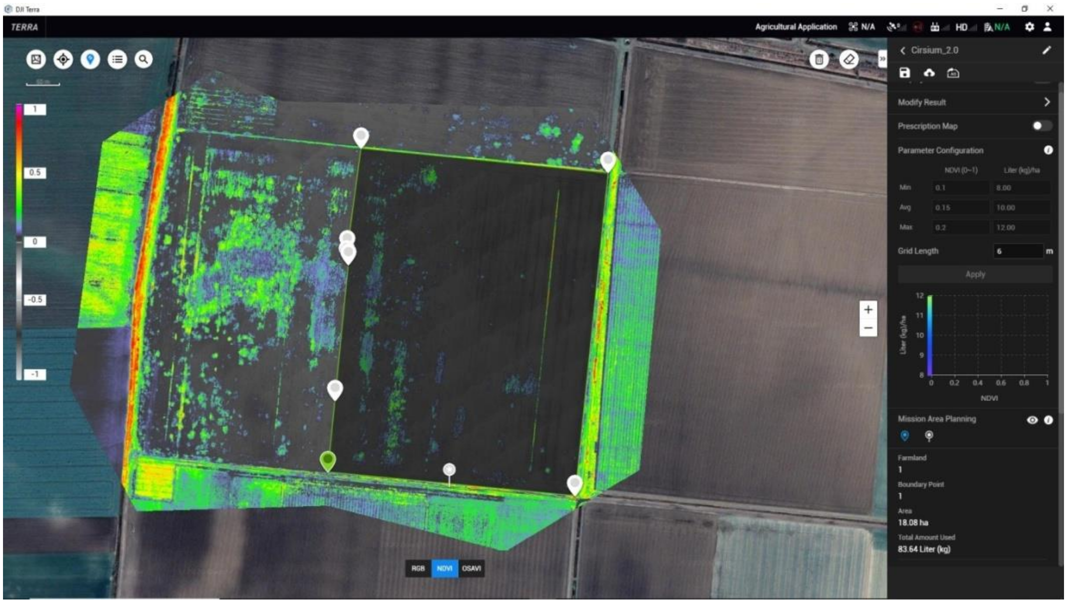

Figure 1. NDVI picture of the different infected areas (left side: control, right side: before treatment).

The treatment took 2.5 hours to finish the VRA zone spraying for our Beta Version Agras T20 drone, which means 7.2 hectars/hour with 6 m route width, on 2,5-3 m route altitude. The weather on the day of the experiment was: 18 °C and 5 km/h wind.

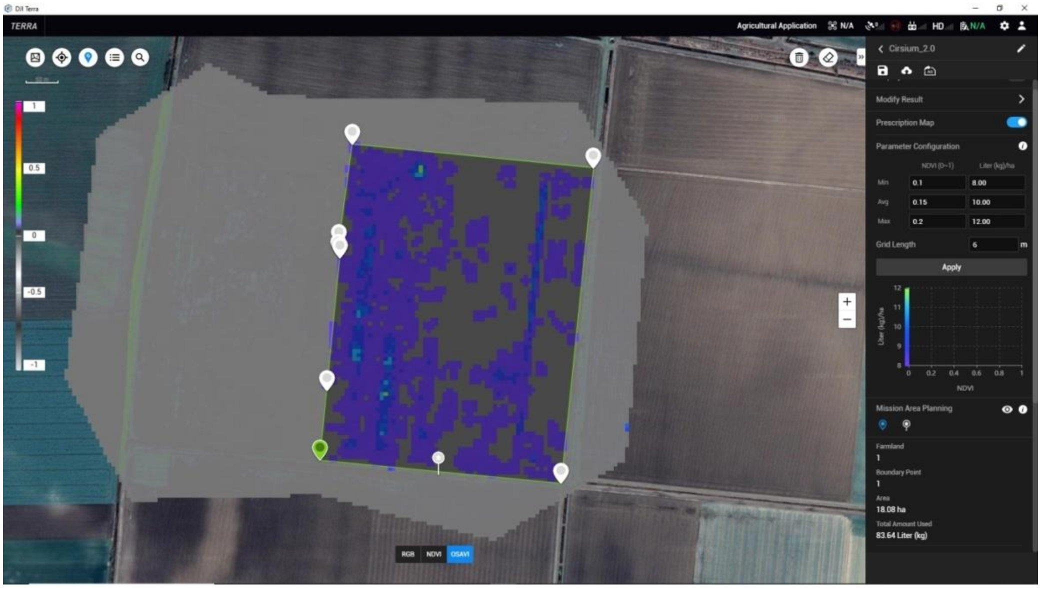

Figure 2. Prescription map of the examined field.

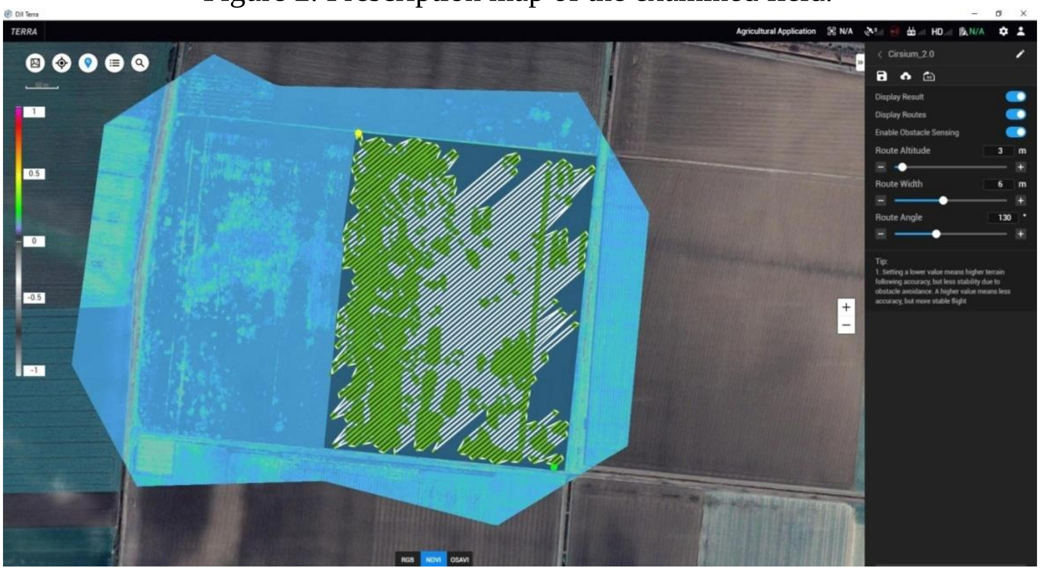

Figure 3. VRA zone spraying (green line: spraying, white line: traveling without spraying)

Results and discussion

We have sprayed Cirsium arvense and other weeds on the 21th of September 2021 and the final efficiency of the application and the choosen dosages were checked on the 12th of October (21 days). The drone used a total ammount of 83 liters of solution, containing 29 liters of glyphosate. The traditional blanket application would have used a total of 90 liters of glyphosate on the 18 hectares, so in our experiment we managed to achieve a 67,78% of chemical saving. We assumed that the higher specific surface area, which is caused by the the smaller droplet sizes of the solution, and the better coverage due to rotor wind were consented to the success. The efficiency of the treatment was the same as traditional methods. Treated areas were monitored manually and by the multispectral drone once a week.

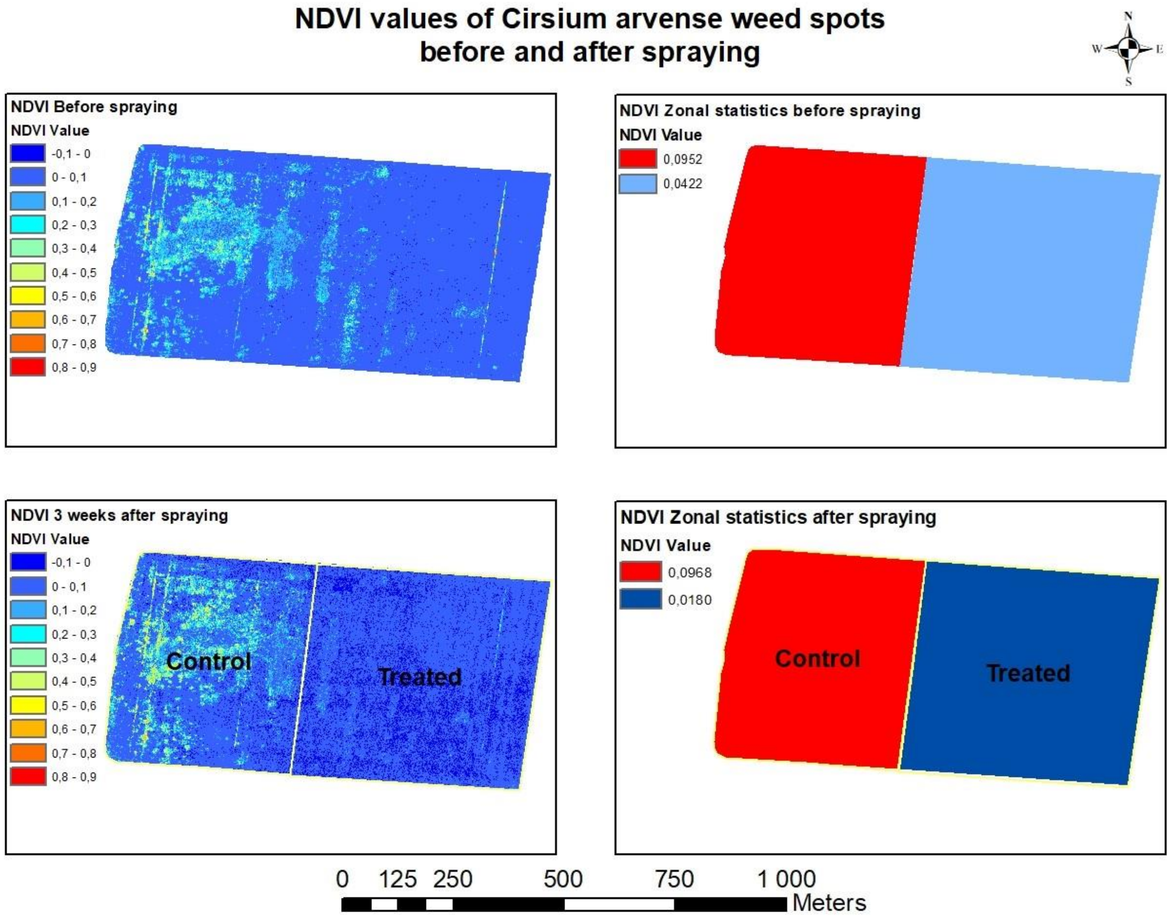

Figure 4. NDVI values of Cirsium arvense weed spots

Figure 5. Treated parcel before and after spraying (21 days).

Acknowledgements
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