Scientific Papers. Series A. Agronomy, Vol. LXVI, No. 2, 2023
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

THE IMPACT OF MONITORING THE STATE OF VEGETATION OF LAVENDER CROPS USING ANALYSIS DRONES

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Abstract

Agriculture evolves from day to day, so that, among the traditional crops, whole fields of lavender have appeared. Apart from its decorative uses, lavender has many other uses, both in the cosmetic and food industries. Lavender growing can become a profitable business for farmers, entrepreneurs and gardeners alike. Lavender is often grown for the benefits of the products it produces. Lavender is a perennial plant that is rarely attacked by pests. As it is considered a niche business, lavender is often grown on small areas. Analysis of the state of vegetation and condition of agricultural crops is done using multispectral drone cameras. These combine data from several separate sensors, so that it is possible to quickly analyse the evolution of the plants, the presence of weeds and insects, the lack of water, etc. In this article we will highlight the impact of using a drone analysis for the purpose of monitoring the state of vegetation as well as the opportunities in finding solutions to control pests and other factors on a field cultivated with lavender in Campia Romana.

***Key words**: unmanned aerial vehicle (UAV), precision agriculture, normalized difference vegetation index (NDVI), green normalized difference vegetation index (GNDVI).*

INTRODUCTION

Agricultural drones give farmers access to in-depth data analysis and farm work planning, as well as new tools for more efficient resource management to reduce manual labour. For farmers, as well as other organisations and institutions involved in crop cultivation and research, drone technology can help them exceed their crop establishment goals and achieve more with fewer resources. Drones can provide high-quality, high-resolution images even on cloudy days (Manfreda et al., 2018). The availability of the drones to be used under different conditions and the speed of transmission are other advantages to be mentioned in literature (Radoglou-Grammatikis et al., 2020). Compared to airplanes, drones are much cheaper and easier to install and maintain (Tsouros et al., 2019). There are several application areas for drones in agriculture. Drones can be integrated with new technologies, capabilities of computing and on-board sensors to support crop management (mapping, monitoring, irrigation, crop diagnostics, etc.) (Huang et al., 2021). Disaster risk reduction, early warning systems, nature and forest conservation, are again other areas that analysis drones can achieve. Drones can be used not only for surveillance, estimation and detection based on sensor data, but also for crop irrigation and weed, pest and disease management. This means that drones can apply precise amounts of water and pesticides based on the information obtained (Rejeb, 2022). The benefits of drones in agriculture are summarised in Figure 1.

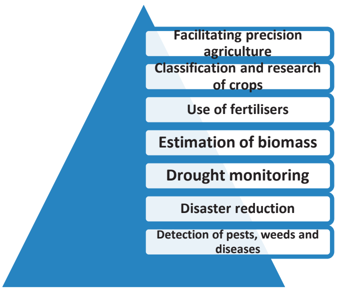

Figure 1. Benefits of drones in agriculture
(Source: Authors' contribution)

Precision agriculture offers opportunities to improve crop productivity and farm profitability through better management of farm inputs (Larson & Robert, 1991; Zhang, Wang & Wang,

2002) and improved environmental quality (Mulla, 1993; Mulla et al., 1996; Tian, 2002). Many farmers strive to apply the latest technology in practice to maximize profits (Seelan et al., 2003), but costs, delivery and information retrieval (especially with remote sensing) may be a barrier to their use in agriculture (Stafford, 2000). Compared to other methods, the use of drones implies much lower cost advantages and significantly better results. Images captured by agricultural analysis drones (UAV - unmanned aerial vehicle) usually have higher radiometric uniformity than aircraft or satellite images due to the lower acquisition altitude (Lelong et al., 2008). However, UAV systems also inherit their own image quality problems. For example, the light weight of many UAV systems means that the camera position is not stable, resulting in different spatial resolutions and/or different viewing angles for different images along the same aircraft (Lelong et al., 2008). The low altitude of these craft can also lead to large geometric distortions (Lelong et al., 2008; Xiang and Tian, 2011). In addition, because of the low altitude, the number of UAV images in each field is also large. There are also technical problems with images captured by UAV-mounted cameras, such as blurring caused by forward motion of the image. Oversampling is usually used to compensate for this but will inevitably lead to increased data volume (Aber et al., 2010).

This improves the data collection process and provides insight into plant health and vegetation management. Given the large amount of images acquired, image decorrelation is a necessary preprocessing step.

MATERIALS AND METHODS

The DJI P4 RTK multispectral cluster drone will be used for research in this article confirm Figure 2.

Figure 2. DJI P4 RTK drone
(Source: Authors' contribution)

Although manual geometric correction has been successful (Hardin et al., 2007; Vericat et al., 2008), it is not suitable for applications in AP (Precision Agriculture) where a larger area of agricultural crops needs to be monitored. There is a possibility for optimizing the turnaround time (i.e. the time it takes to process the final product and get it to the user) which is a major concern for these devices, as hundreds of images are often captured and require a quick response from the manufacturer. As a result, automated processing often dominates UAV data processing. Automated or semi-automated (block file) photogrammetry systems can successfully cope with the roll, pitch, and yaw variations common in UAVs (Laliberte, 2011; Xiang, 2011). However, due to the small scan strip area and unstable platform, geometry and orthorectification are also required before combining images. The methods developed to solve these problems include: manual georeferencing using GCPs (ground control points) collected in the field, photo matching, and automatic georeferencing using navigation data and camera lens distortion models (Xiang, 2011). Agricultural imaging obtained is easier and more efficient than ever with a built-in stabilised imaging system that captures complete data sets immediately. The information is collected by an RGB camera and a series of five-camera multispectral cameras as shown in Figure 3, covering the blue, green, red, red and near-infrared bands. All these cameras are 2MP in size and have a global shutter on a 3-axis stabilized gimbal. An integrated solar spectrum sensor on top of the drone captures solar radiation, maximising the accuracy and consistency of data collection at different times of the day.

Figure 3. DJI P4 multispectral camera
(Source: Authors' contribution)

All users who own a drone that weighs more than 250g or is equipped with a camera and microphone must register with the Romanian Civil Aviation Authority before obtaining a flight permit. Using the DJI GS PRO app (the main iOS app for DJI flight planning) compatible only with iPhone devices (tablets), flight missions are set up on the investigated plots as shown in Figure 4.

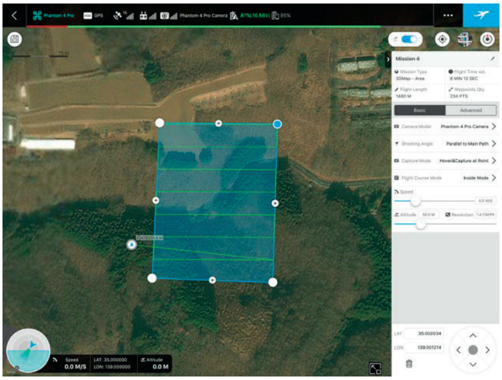

Figure 4. DJI GS PRO application
(Source: Authors' contribution)

After the drone flight mission is set up over the lavender fields in the Baragan Plain, images of the vegetation condition of the studied crop, specifically the lavender crop, will be collected. After several flight missions, these images will be analysed and, of course, we will try to interpret these images through the colour spectrum, both in terms of fertilisation and the use of plant protection products. The images obtained from the flight mission over a herb crop plot with all 6 multispectral cameras can be seen in Figure 5 as follows:

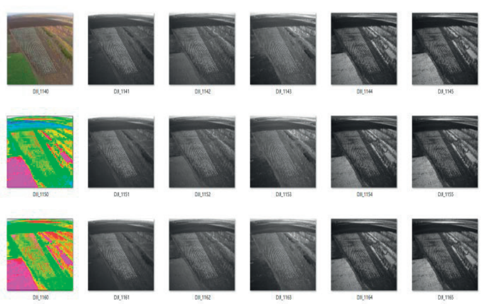

Figure 5. Images obtained with the DJI 4 RTK
(Source: Authors' contribution)

PIX4Dfields is advanced agricultural mapping software for plant analysis and digital agriculture. Therefore, after obtaining high-resolution images in natural or multispectral colour, the PIX4Dfields application provides easy access to a wide range of tools and functions for creating orthomosaics, vegetation indices and annotations. Performing this statistical analysis as shown in Figure 6, is shown by inserting all collected images. Regardless of the type of drone or camera, PIX4Dfields requires a careful analysis of the flight plan parameters in order to obtain and process an appropriate data set.

Figure 6. Merging the collected images and obtaining NDVI index maps (Source: Authors' contribution)

NDVI (Normalised Difference Vegetation Index) quantifies vegetation by measuring the difference between near infrared (which vegetation reflects strongly) and red light (which vegetation absorbs).

RESULTS AND DISCUSSIONS

Two types of crop mapping maps are produced using drones. RGB and NDVI (Normalized Difference Vegetation Index) maps showing the amount of infrared light reflected in an area, providing a panoramic view and allowing crop monitoring - an indicator of crop health. NDVI is a dimensionless index that represents the difference between visible and near-infrared reflectance of vegetation cover, it can be used to estimate the green density of upland areas (Weier and Herring, 2000). NDVI is calculated as the difference between near infrared (NIR) and red (RED) divided by the sum.

$NDVI_i=(NIR-ROȘU)/(NIR+ROȘU)$,

$NDVI_i$ represents the smoothed NDVI (NDVI) observed at time step i and their ratio gives a measure of photosynthetic activity in values between -1 and 1. Low NDVI values indicate moisture-stressed vegetation and higher values indicate higher density of green vegetation. According to the interpretation results using the Pix4Dfields application together with the QGIS application, we obtained an area map of the analysed plots, so as shown in Figures 7 and 8.

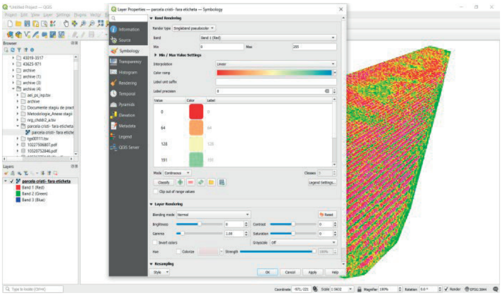

Figure 7. Obtaining histograms and spectral bands (Source: Authors' contribution)

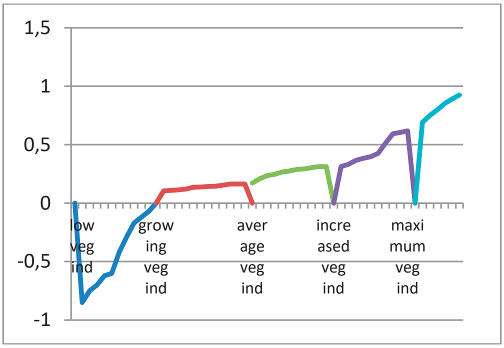

Figure 8. Results of vegetation indicators of the studied crop (Source: Authors' contribution)

From the zonation map we can see that the values obtained range from -1 to +1. where -1 indicates an extremely low degree of vegetation and +1 indicates a high degree of vegetation. The processing software separates these values by colour to better distinguish between diseased and healthy vegetation in a given area. The normalised vegetation index (NDVI) is
the oldest, best known and most widely used vegetation index. The spectral range with the highest degree of absorption and reflection associated with chlorophyll activity is used for the calculation required in our crop. For green vegetation, the most common range is between 0.2 and 0.8. Almost 75% (74.90%) of the crops surveyed were observed to have vegetation conditions at medium to high levels. These calculations automatically lead, in the case of foliar products and plant protection products, to a decrease in the quantity used during the harvest of herbs. The savings are significant in terms of fuel used in conventional machinery and, of course, in terms of marketed inputs compared to conventional methods that allow for crop control and farm operation expenses, will be around 25%.

CONCLUSIONS

The introduction of drones in agriculture will allow this branch of economy to reach a new level in terms of the quality of the harvests obtained in strict accordance with the Common Agricultural Policies (CAP) in order for farms to be competitive and efficient on national and international markets. Monitoring plant health using drones to make correct 'phytosanitary' decisions based on the number of affected plants (weeks before emergence) leads to accurate estimation of infection rates and proper fertiliser application. The same aspect is definitely achievable in the case of monitoring the vegetative state of plants for the use of plant protection product treatments in collaboration with a careful monitoring and evaluation of the damage done after weather events due to the climate change. Information-based technologies need to be developed and promoted for the vast majority of agricultural crops and of course at affordable prices. In this way, agricultural drones ensure efficient surveillance of agricultural crops, simplify the use of new technologies, so that they become a tool for collecting data on established crops, data that will be of real use to the entire farming community.

ACKNOWLEDGEMENTS

The work of Cristinel Fertu was supported by the project "Programme for increasing performance and innovation in excellent doctoral and postdoctoral research" - PROINVENT , Contract nr. 62487/03.06.2022; POCU/993/6/13 - Cod SMIS: 153299.

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