Homologation and inspection of spray drones in Switzerland

Thomas Anken

Agroscope, Tänikon 1, CH-8356 Ettenhausen

Introduction

Drone technology has made great progresses in recent years. Unmanned multicopters can follow a predetermined flight route very accurately and offer very interesting potential for plant protection in steep slopes of vineyards. Under such conditions, they can replace a lot of manual work and are a promising alternative to applications by helicopters. As no drones are homologated for spraying in Europe so far, standardized procedures are needed to fill this gap. In Switzerland a first type of drone has been homologated. This drone now underlies the same regulations as standard orchard sprayers. As drift measurements have proven a low drift potential of this technique, drones offer an interesting potential for the application of plant protection products.

Multicopters work very accurately

In very steep vineyards the application of plant protection products with hand-held devices is the only alternative to the helicopter. For this reason, airborne application is still important in Switzerland and has been regulated by the federal offices (BAFU 2016). However, the noise emissions as well as the pesticide drift caused by helicopter applications lead to many discussions. In contrast to the strong air stream of big and heavy helicopters, the drones which currently weigh between 20 and 40 kg create a relatively weak airstrem. Probably due to their counter rotating 6-8 propellers, no vortex has been detected so far for multicopters. This seems to be an advantage compared to helicopters with one single rotor.

With their horizontally rotating rotors, multicopters cause a vertical air stream that accelerates water drops towards the ground. In contrast to the air flow of conventional orchard sprayers, which is oriented in the orchard in a horizontal or upwards direction, the vertical, soil oriented air stream of drones seems to be advantageous in terms of drift reduction. First measurements of pesticide drift in Switzerland have shown a low drift potential.

These positive properties motivated the different actors to establish a simple procedure to homologate drones for the application of plant protection products in Switzerland.

Elements of the homologation in Switzerland

A homologation procedure was developed in collaboration with the federal offices for environment, agriculture, health, economic affairs and aviation. The drafts have been elaborated and are currently being finalized. The procedure shall be definitively implemented in the coming year. This homologation should consist of the following steps:

Agroscope carries out the technical tests of spray drones

The results are sent to the Federal Office for the Environment, which makes a decision regarding the environmental aspects.

In last instance, the Federal Office of Civil Aviation examines if the regulations of the civil aviation are respected. The Swiss Civil Aviation rules for drones can be found under the following link. https://www.bazl.admin.ch/bazl/en/home/good-to-know/drones-and-aircraft-models/allgemeine-fragen-zu-drohnen.html

In case of a successful homologation, the drones are treated as standard orchard sprayers and have to pass the sprayer inspection every three years.

Technical criteria for the homologation in Switzerland

Based on the ISO standard protocols, for the inspection of sprayers a new protocol for the inspection of spray drones has been established (Table 2).

Table 2 Draft of the technical characteristics for the homologation of spraying drones in Switzerland.

Element	Characteristics
Pump and tubes	The entire spray system must be leak-proof at the maximum achievable system pressure. No pressure regulation is requested. Hoses must be arranged so that no kinks and frictions occur.
Agitation system	Circulation of the spray mixture to agitate the spray mixture and to rinse the spray tank must be possible. The agitation does not have to take place at the same time as the application.
Nozzles	The pressure generated by the pump must be such that the working range of the nozzles is within the approved range according to JKI nozzle tables. Flow rate of the individual nozzles compared to the ISO nozzle table: +/- 15% Deviations of the individual nozzle output from the mean output: +/- 10%. Anti-drip: No dripping of the nozzles more than 5 seconds after the spraying has stopped.
Lateral distribution	Testing on a groove patternator with a width of at least 3 m, length 6 m and at least 1.5 times the length of the application width of the drones. Coefficient of variation of the quantities of all grooves: max. 15% (mean of 3 individual measurements)
Tank	The tank has to be leak-proof and its level should be easy to read. Residual volume should be lower than 4%.
Pressure gauge	A pressure gauge is to be carried as an accessory. It should be coupled directly into the spray circuit for control and not alter the flow of the system. The scale must have at least a subdivision of 0.1 bar for working pressures up to 5 bar. The accuracy of the manometer must be at least +/- 0.1 bar of the real value.
Strainer	No separate strainer is necessary on the drone, nozzle filters are sufficient.
Drone-port	The spray drone must be able to land on a drone-port covered with a grid or a perforated plate for filling, emptying and rinsing. The content must be at least 100% of the sprayer tank volume of the drone and cover the entire length and width of the spraying equipment. This drone port must allow lossless rinsing of the drone. The complete emptying of the drone port should be carried out by means of a tap or a pump into lockable containers.
Autono-mous navigation	The drone must be equipped with a precise navigation system. Deviation from a predefined flight route: max. +/- 50 cm. The decisive factor is the nozzle height and the center of the application system. The flight route has to be planned before the flight. Afterwards, the drone has to fly the route automatically without further human intervention and execute the spraying process within the predefined perimeter. Switching on and off of the spraying process must be fully automatic. For take-off and landing, human intervention is allowed. In case of more than one flight on the same perimeter (ex. after an empty tank), the drone must automatically restart the spraying process with a precision of +/- 50 cm from where it finished the spraying at the previous flight. Manually switching off the spraying process and human takeover of the drone must be possible at all times.

Wind speed	Wind speed of the drone's airflow is measured on an open field covered with grass by means of tridimensional wind-speed sensors at distances of 10 and 20 m laterally from the drone. The tank of the drone has to be filled completely. Maximum allowed wind speeds are indicated in Table 3

To estimate the risk of the spray drift, the wind speeds of the airflows of drones are measured in different distances from the drone. Compared to standard orchard sprayers, which often show speeds of the air stream around 8 m/s, lower maximum speeds for drones between 2 and 5 m/s are proposed to allow their homologation without extra drift measurements (Table 3). This procedure shall allow for the quick testing of drones and make it possible to estimate the risk of drifts of new models.

Table 3 Proposed speed limits for the airflow of drones.

Distance to drone	Height above soil	Maximum speed of the air flow m/s
10 m	1 m	5 m/s
	2 m	3 m/s
20 m	1 m	3 m/s
	2 m	2 m/s

Outlook

Goal of the proposed homologation process for drones is to allow an efficient, simple and non-bureaucratic process. As aerial applications of plant protection products underlie specific rules, supplementary restrictions have to be taken into account. As the first experiences are very positive and several companies are already demanding the homologation of their drone, we expect to put the new homologation process into force for 2019.

Nevertheless, we hope that standardized protocols will be established on a European level very soon. They should allow to simplify the whole process and to guarantee the mutual recognition of spray drones like this is implicitness for all other sprayers.

Literature

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