Unmanned aerial system – new vector control technology

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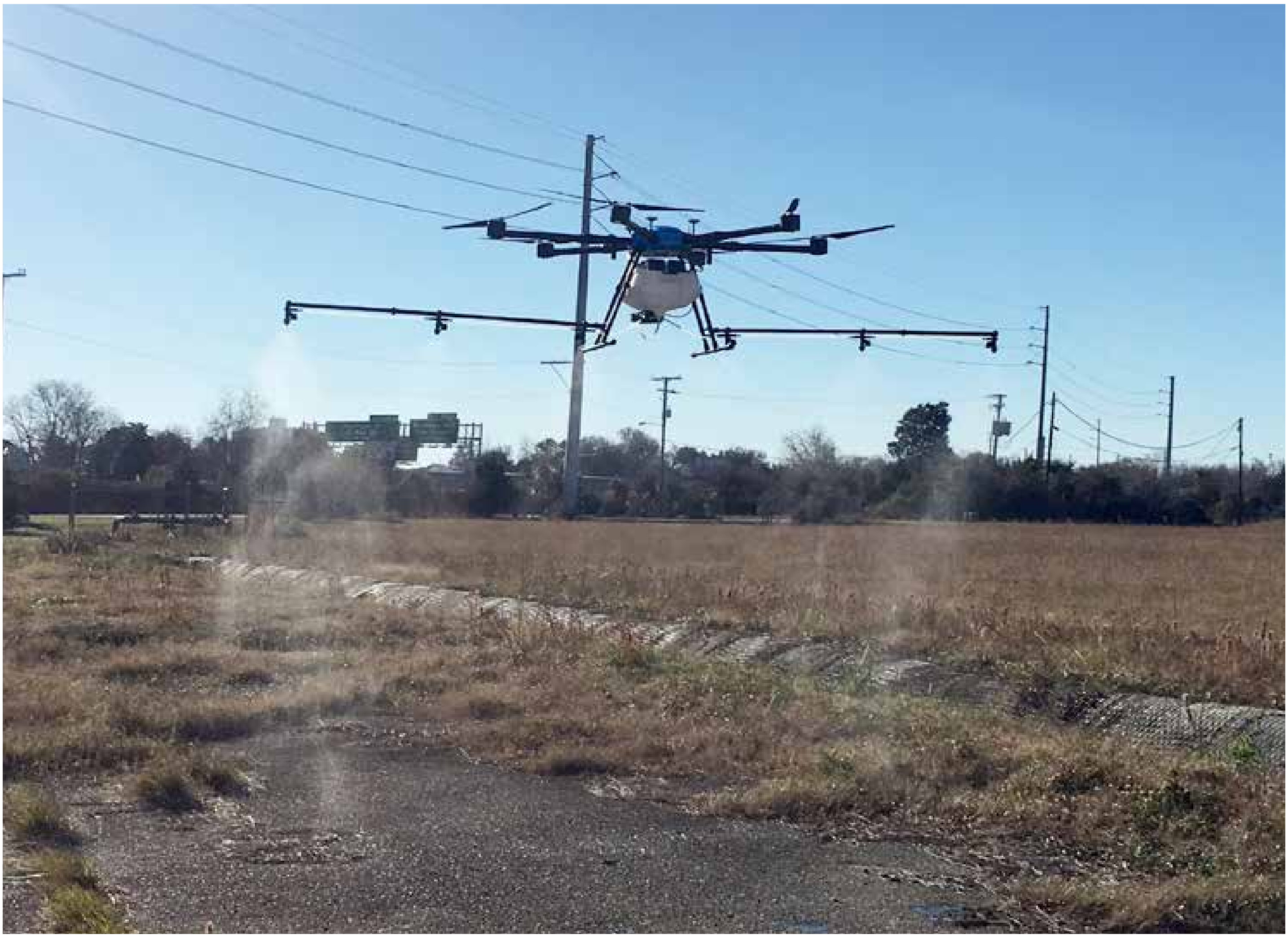

Figure 1: Small unmanned aircraft system (sUAS) during a liquid application.

'Global Vector Control Response 2017 – 2030' released by WHO (2017) establishes new guidelines which aim to reduce the burden and threat of vector-borne diseases through effective locally adapted sustainable vector control. New technologies in formulations and applications have provided us with advanced tools for designing effective vector control programs worldwide.

In recent years, unmanned aircraft system (UAS) technology has been developed for performing dull, dirty or dangerous missions for the military but this technology has rapidly expanded into many other areas such as commercial, scientific, recreational and agricultural applications. UAS includes an unmanned aircraft vehicle (UAV or drone), a ground-based controller and a system of communications between the two. The UAVs may operate with various degrees of autonomy, either under remote control by a ground pilot or autonomously by onboard computers.

The PrecisionVision® unmanned aircraft system, developed by Leading Edge Aerial Technologies is designed specifically for the aerial application of both liquid and granular products as well as Ultra Low Volume (ULV) adulticide applications. This is accomplished through the integration of the PrecisionVision iOS (restricted to Apple iPhone and iPad) app with the company's Avionics suite, its UAS and the various payload systems. It has been used for imagery and aerial applications in the forestry, agriculture, noxious weed and mosquito control industries in the United States.

The UAS is built on an industry standard carbon fibre airframe. Paired with six independent propulsion motors and

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props, the UAS aircraft provide what the company regards as the ultimate platform for aerial applications. The UAS (Figure 1) is configured with the liquid adulticiding application payload system. The liquid and granular application systems are interfaced with the iOS app which is specifically designed for aerial applications using unmanned aircraft systems. Leading Edge Associates software engineers designed and programmed the app with a comprehensive understanding of the system and more than 33 years of experience in the aerial application industries of mosquito control, agriculture, forestry and noxious weed control. Multiple types of spray patterns, user defined swath width, ground speed and altitudes are just a few of the application variables pilots can choose from. Everything is fully autonomous, including the precision control of the spray system's on and off operation (Figure 2).

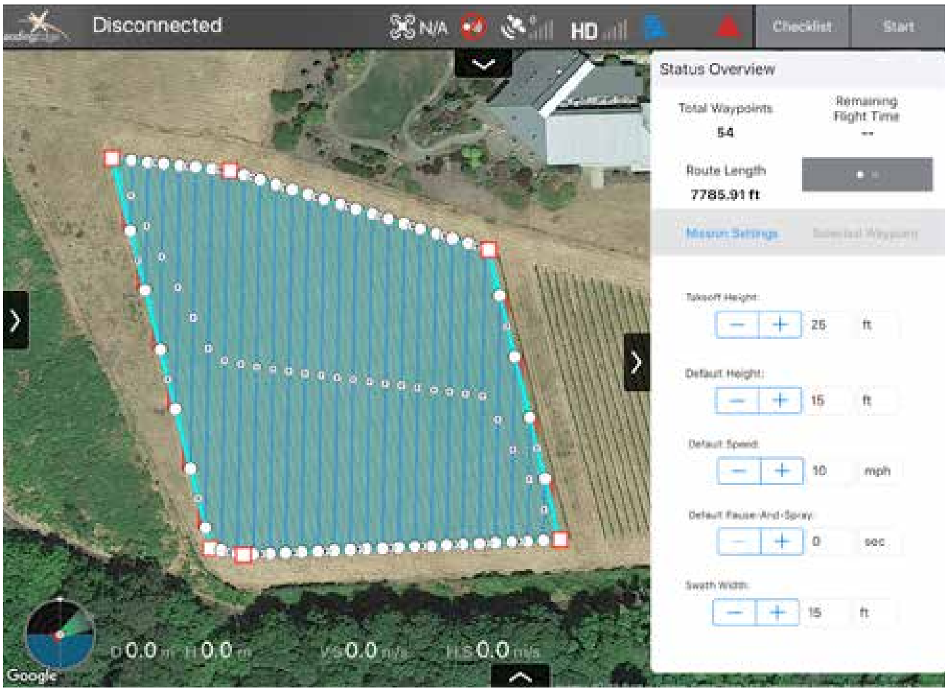

Figure 2. The PrecisionVision iOS app is specifically designed for aerial applications using UAS.

Adulticiding trial using sUAS

The first aerial Ultra Low Volume (ULV) space spray study using PrecisionVision sUAS was carried out in collaboration with the East Side Mosquito Control District in Modesto, California in June 2018. Bayer Imperium™ Aerial Insecticide (Bayer CropScience LP) was used to apply active ingredient deltamethrin at 1 g ai/hectare (0.00089 lb ai/acre) against Culex quinquefasciatus, a Zika virus carrier.

Aerial adulticiding for wide area mosquito control is routinely used by mosquito control districts. However, using a sUAS is a new aerial application technology in the industry. The sUAS used for the study was equipped with two Micronair (Micron Group) rotary atomizers, one mounted on the end of each side of the sUAS (Figure 3). This application system is specially designed for maximizing the even dispersion of droplets exiting the nozzle. The target flow rate used for the application was 177 ml/min based on an aircraft speed of 6.3 metres/sec, a 91 m swath width and three passes. The sUAS was fully equipped with PrecisionVision Avionics Suite that could map out the complete flight paths and recorded numerous application-specific parameters (Figure 4).

Prior to the aerial application, the UAS was calibrated to ensure the target flow rate was within 10% accuracy. An aerial calibration spray determined that the →

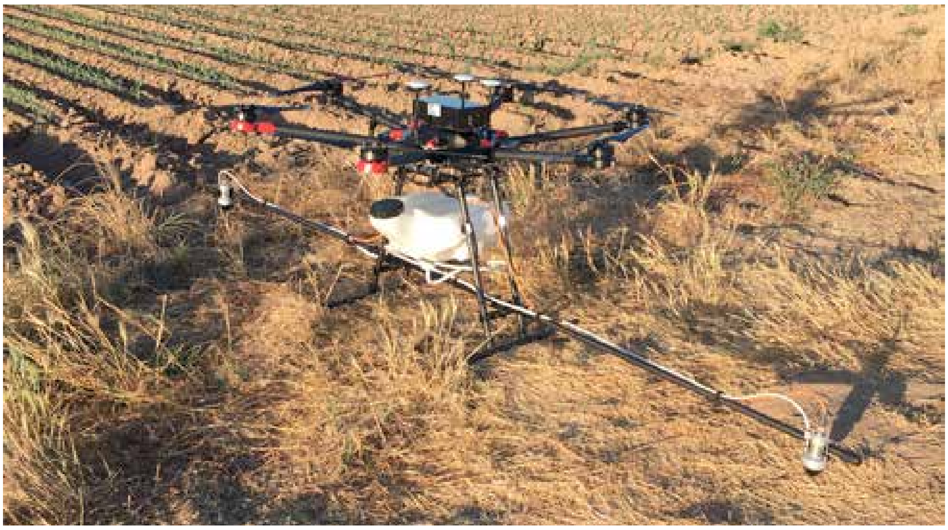

Figure 3: sUAS with PrecisionVision 600P and Micromizers.

VMD AND DV EXPLAINED

VMD = Volume Median Diameter. The size of droplet – usually measured in microns - at which half the volume of spray is in droplets smaller and half in droplets larger. The DV0.5 is the same as the VMD.

DV0.9 indicates the droplet size at which 90% of the spray by volume is in droplets smaller and 10% in droplets larger. A large DV0.9 (e.g. 750 microns) would indicate most of the volume is in large droplets and efficacy may be reduced. Using DV0.1 (10% of volume under this size), DV0.5 and DV0.9 it is possible to get a measure of the width of the droplet spectrum of a nozzle and its suitability for a given job.

EXPERIMENTAL PARAMETERS

Start time	13:05:12 UTC	
End time	14:03:05 UTC	
Offset distance	0 feet	0 metres
Release height	50 feet AGL	15.2 metres
Number of passes	3	
Average ground speed	14 mph	22.5 km/hour
Swath width	300 feet	91.4 metres
Swath 1 spray on time	1’6”	
Swath 2 spray on time	1’8”	
Swath 3 spray on time	1’16”	
Total spray time	3’32”	
Flow rate	6 fl oz/min	0.18 l/min
Total DeltaGuard applied	19.92 fl ounces	0.59 litre
Area treated	29.72 acres	12 hectares
Application rate (a.i.)	0.00089018 lbs/acre	1 g/hectare

Figure 4. Recorded flight paths and other application parameters.

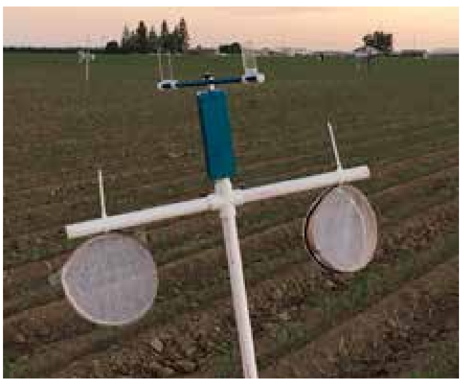

Figure 5. Each sampling station consisted of two mosquito cages and a droplet sampler

droplet sizes (VMD/DV0.5 = 45 microns and DV0.9 = 59 microns) dispersed from the nozzle of the sUAS were within the range of values of DV0.5 < 60 microns and DV0.9 < 115 microns specified on the Imperium product label. (See Box for explanation of VMD, DV0.5 and DV0.9)

For treated plots, three replicate rows of stations were established. Each row was set up 61 m away from each other. Each sampling station consisted of two mosquito cages and a droplet sampler with a Teflon-coated slide (Figure 5). Droplet sampler slides and mosquito cages were collected approximately 20 minutes after the end of application. The mosquitoes were transferred into fresh untreated assessment containers and provided with a cotton ball soaked with sugar water solution as a food source and kept at room temperature. All collected mosquitoes were assessed for knockdown and mortality at approximately 1 hour and 12 hours after application, respectively. Collected Teflon-coated slides were analysed for droplet spectrum using DropVision (Leading Edge Associates, LLC).

The average droplet sizes ranged from 31 to 50 microns across the three distances of 0, 61, and 122 m from the first spray path. The average droplet density ranged from 1.12 to 1.34 droplets/mm2 across the three distances from the first spray path. The knockdown at 1 hour after application ranged from 94.5% to 99.4% for the treatment group and was noticeably greater than that for the untreated control group (1.3 %). Complete mortality was achieved at 12 hours after application.

The consistency in the droplet spectrum observed among the three spray path distances indicated an even dispersion of the DeltaGard formulation on a large portion of the treatment plots. High knockdown (94.5% to 99.4 %) and mortality (100 %) was achieved using a low application rate of 1 g/hectare. The result indicated that the small unmanned aircraft system application of Imperium Aerial Insecticide was effective at adulticiding against Culex quinquefasciatus.

An additional aerial study using the PrecisionVison sUAS ULV application of Imperium against Aedes aegypti was conducted in collaboration with the Manatee County Mosquito Control District in Palmetto, Florida in the summer 2018. The study used the same general design. However, the sUAS was offset 15 m from the first row of cages; the flow rate was calibrated to deliver 150 ml/min with the aircraft speed of 8.5 metres/sec and the swath width 61 m. All treated cages achieved complete knockdown at 1 hour and complete mortality at 12 hours.

Given the high mosquito mortality achieved using the unmanned aircraft system to apply Imperium Aerial Insecticide at both the California and Florida field sites, this advanced vector control technology is considered an effective and versatile tool. ■

All photos: Eurofins or Leading Edge