EVALUATION OF LARVICIDE TREATMENTS BY DRONE AGAINST MOSQUITOES IN WETLAND AND AGRICULTURAL AREAS OF PO RIVER DELTA, ITALY

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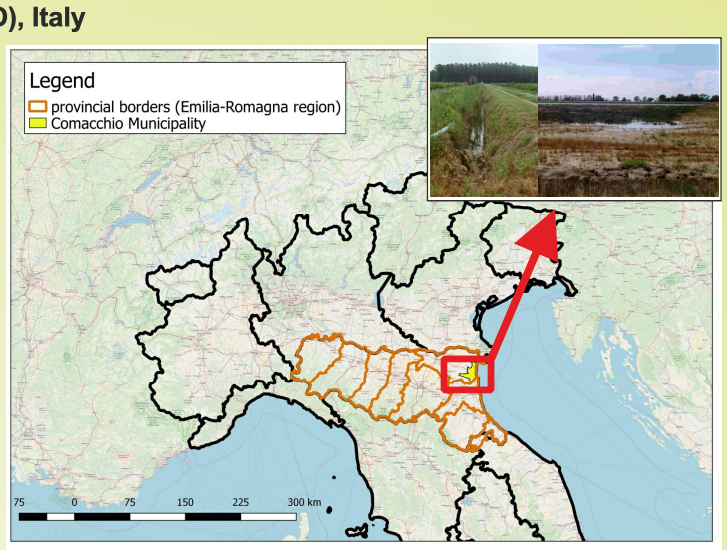
Introduction

Conventional ground larval mosquito control operations have some limitations particularly in wetlands and agricultural areas, due to vegetation and accessibility constraints, which have a major impact on their effectiveness. This is why in some areas of Po river Delta (Municipality of Comacchio, Emilia-Romagna region, Italy), a preliminary test was conducted in September 2017 on the using of unmanned aerial vehicles (drones) to map flooded areas (*Aedes caspius* and *Aedes detritus* breeding sites) and to perform larvicide treatments by *Bacillus thuringiensis israelensis* (*B.t.i.*). New field tests were conducted in June 2018 by *B.t.i.* and by *B.t.i.* + *Lysinibacillus sphaericus* (*L.s.*), against *Ae. caspius* and *Culex pipiens* in agricultural areas. The possibility to automate the drone to independently perform larvicidal treatments only where is necessary has been also tested.



Materials and Methods

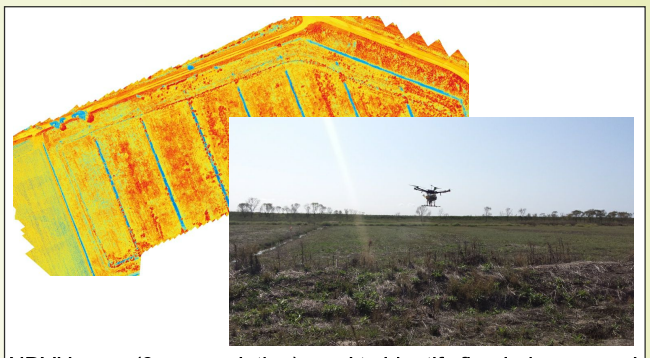
Drone Model: Aermatica3D BLY-C (based on DJI Matrice M600)

Technical features

Machine size (W-L-H):1.6 m - 1.5 m - 0.7 m
Spraying tanks: 10 L / 10 kg
Net weight: 9.6 kg
Flying time: 20 min
Max speed: 17 m/s
Max opertive speed: 7 m/s
Spray flow: 3.6 L/min - 500 g/min
Spray width: 2.5 m
Nozzels number: 2

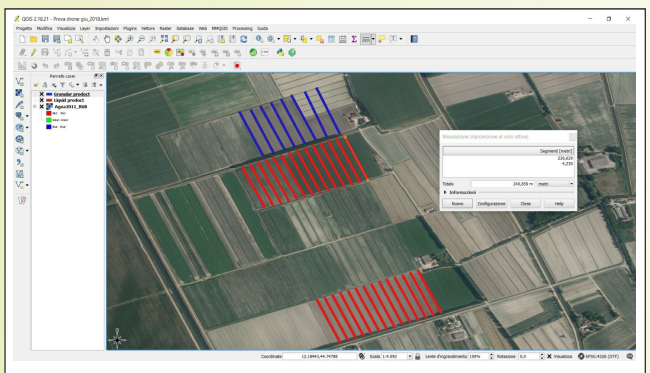
Targets of 2017 trials were: 1) a preliminary test to understand the treatment time; 2) evaluation of the performance of the technology available for natural flooded areas (two drone models used: one for high resolution NDVI and one for the treatment by liquid *B.t.i.*).

Study area 2017 (natural flooded area) with sample points (2 not treated and 8 treated) and a field technician sampling by dipper.

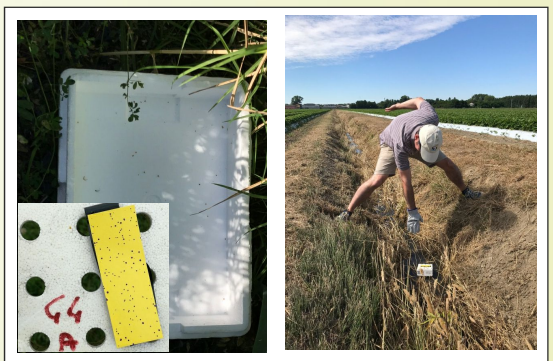


NDVI image (3 cm resolution) used to identify flooded areas and the drone in action.

Targets of 2018 trials were: 1) testing the ability of the larvicidal product (liquid *B.t.i.* and granular *B.t.i.*+ *L.s.*) to reach the water of agricultural ditches/streams; 2) evaluation of the larval mortality based on the technical parameters adopted for the drone flight (speed, flight height, dose of the formulation); 3) assessment of the efficiency of the drone flight plan system based on the upload of pre-digitized breeding sites by GIS into memory drone and evaluation of productivity expressed in hectares/hour.



Study area 2018 with agricultural ditches to treat and mapped on GIS (QGIS 2.18) , then transferred into drone memory.



Yellow cards and plastic trays used to evaluate the ability of liquid and granular products to reach the water.

Results and Discussion

RESULTS TRIAL 2017

Area	natural flooded area
Treated surface	4 ha
Larvicide	liquid *B.t.i.*
Dose rate	2 L/ha
Flying height	3 m
Flying speed	3 - 5 m/s
Swath width	2.5 m
Total Flying time	35 min
Spray efficiency	0.11 ha/min
Mortality	79.5 % (*Aedes caspius*)

RESULTS TRIALS 2018

Trial 1

Area	streams/ditches
Treated surface	~ 1.4 ha (14 linear km)
Larvicide	liquid *B.t.i.*
Dose rate	4 L/ha
Flying height	5 m
Flying speed	3 m/s
Swath width	1.5 m
Flying time	6 min
Spray efficiency	~ 0.1 ha/h (1 linear km/h)
Mortality	> 90% (*Ae. caspius/Cx. pipiens*)

Trial 2

Area	streams/ditches
Treated surface	~ 0.2 ha (2 linear km)
Larvicide	granular *B.t.i.*+ *L.s.*
Dose rate	20 kg/ha
Flying height	5 m
Flying speed	2.5 m/s
Swath width	50 cm
Flying time	8 min
Spray efficiency	~ 0.1 ha/h (1 linear km/h)
Mortality	100% (*Ae. caspius/Cx. pipiens*)

The trials conducted during summer 2017 and 2018 confirmed the use of drones as good tool for larval treatment of natural flooded areas/marshes and agricultural ditches/streams against *Ae. caspius* and *Cx. pipiens* with a mean yield of about 0.11 ha/min for flooded areas and 0.10 ha/h for ditches and a mortality against *Ae. caspius* and *Cx. pipiens* that range from 80 to 100%. Best drone performance and efficacy were reached with granual product (*B.t.i.*+ *L.s.*) that better penetrate through vegetation and reduces the drift effect. In particular this technology is very good for areas difficult to reach by feet or by 4x4 vehicles that remain at the moment the most effective and costless technology for programmed larval treatments of road diches. Further trials will be necessary to improve the performance of drones and also to find new protocols to speed up passage from GIS shapefile and memory drones.

AKNOWLEDGMENTS

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