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RESEARCH ON RICE January 1, 2017 -
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PROJECT TITLE:
Targeted, Spot Spraying of Rice Weeds from Remotely-Piloted Aircraft

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PRINCIPAL UC INVESTIGATORS: (include departmental affiliation): Kassim Al-Khatib, Plant Sciences, UC Davis; Whitney Brim-DeForest, UC Cooperative Extension; Luis Espino, UC Cooperative Extension.

COOPERATORS: Bill Reynolds, Leading Edge Associates, Inc.

LEVEL OF 2017 FUNDING: $5,800.

OBJECTIVES AND EXPERIMENTS CONDUCTED, BY LOCATION, TO ACCOMPLISH OBJECTIVES:

The objective of this project was to initially assess the performance and feasibility of using remotely-piloted aircraft (RPA), also called unmanned aerial vehicles or “drones”, to treat patches of weeds with herbicide.   If weed or pest patches or targets will be identified by remote sensing, physically walking the plots and by some method therefore mapping the target weed patches with an RTK GPS system capable of centimeter-scale accuracy, the application of control material can be achieved by Remotely Piloted Aircraft.   The project had applications for control of weedy rice by allowing highly targeted treatment of weed patches using non-selective herbicides. This project was conducted at the Rice Research Station, with cooperation of Kassim Al-Khatib, in experimental plots containing common rice weeds in September 2017. While weedy rice was not present in these initial experiments, the experiments focused on the *physical* process of treating small target patches and were directly applicable to all weeds (and for that matter, other insect and disease pests) that are patchy in rice fields, including weedy rice.

Simulated target maps were used to guide a small RPA (DJI Agras MG-1S), fitted with a spray system for spot treatment, to the weed patches and apply water from the spray system (delays in obtaining regulatory approval for chemical dispersion prevented the application of active ingredients in 2017). Water sensitive paper was used for visual assessment of the immediate spray deposition performance.

The agricultural spray lab in the Biological & Agricultural Engineering Department at UC Davis received the first FAA permit for pesticide application from RPA and has 5 years of experience with RPA spraying. One aircraft currently in use by the lab is the Yamaha RMAX, a conventional design helicopter with a gasoline engine. The RMAX, which weights over 100 kg (220 lbs) is currently unsuitable for this application due to its limited electronics and operator interface although a more capable version is in development and may be available in future seasons. The RMAX, unlike the MG-1S, has no GPS provisions for spot spraying and requires visual positioning by the operator. The RMAX is designed for broadcast spraying, not precision application or autopilot-guidance operation. While the RMAX has been tested in broadcast rice spraying for two seasons, the inherent limitations in the control system and the current business model for use of the aircraft in the U.S. (the manufacturer is also the custom applicator) make it suitable, and potentially superior to the MG-1S, for *broadcast* applications only, not targeted spraying.   However, it should be noted that while the MG-1S is being used to establish this use in rice in this project; other manufacturers are developing similar RPA and spray system products.

The feasibility results from 2017 testing at the Rice Research Station were extremely positive. The MG-1S (Fig. 1) was fitted with an RTK GPS, referenced to a base station (Fig. 2) and a number of target locations in rice plots were mapped using a mobile RTK receiver (Fig. 3); this simulated detected or mapped weed locations, such as weedy rice infestations. The aircraft was fitted with four 8005 flat fan nozzles, each under a rotor (the helicopter is a octorotor aircraft but only four rotors have nozzles). A 36-inch “bullseye” target was fabricated to secure water-sensitive papers for recording spray deposition (Fig. 4) and positioned at the center of the mapped target location. The aircraft was guided to the target and positioned to hover over the target and apply an application rate of approximately 1 gallon/acre (Fig. 5). Results were consistently encouraging – the pilot was successful in positioning the aircraft and spraying the target with good deposition across the target area (Fig. 6).

Fig. 1. The DJI Agras MG-1 Multi-rotor helicopter for agricultural spraying (manufacturer’s graphic).


Fig. 2. Aircraft and base station set up.


Fig. 3. Mobile RTK GPS mapping weed targets.


Fig. 4. Bullseye ring with water-sensitive paper positioned at mapped target.

Fig. 5. Aircraft positioned by reference to GPS target and hovering to make spray spot treatment.

Fig. 6. Results of example target spray.

SUMMARY OF 2017 RESEARCH (major accomplishments):
Through field testing at the Rice Research Station, it was proven that a small, relatively low cost RPA (~ $20,000 with batteries and chargers) could accurately treat, in a highly accurate manner, within 1 meter, a target area within a mature rice field. Repeatability was high in that multiple replications, over ta number of days, consistently showed effective deposition of liquid spray. The commercial vendor, Leading Edge Associates, from which the RPA was purchased and who cooperated on the project is currently a licensed FAA Part 137 aerial application operator and will cooperate in 2018 in further studies of efficacy and drift. Currently, California regulations require that operators of remotely piloted aircraft for spraying be licensed agricultural pilots; this limits widespread adoption and use in the short term.

PUBLICATIONS OR REPORTS: None to date, all work is preliminary feasibility work.

CONCISE GENERAL SUMMARY OF CURRENT YEAR'S RESULTS: A small, $18K, electrically-powered, remotely piloted aircraft was used to apply liquid spray in a highly accurate and repeatable manner to simulated pest targets in a rice field.