

Drones for Weed Management

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Drones in agriculture

At first:

Fun toy

Take nice pictures

Take pictures of yourself driving equipment

Keep an eye on your neighbors

Now:

Soil characteristics

Locate drainage tiles and pipelines

Crop nutrient stress

Irrigation problems

Crop emergence or stand issues

Weed species and infestation level

Detect insects and diseases

Monitor livestock

Spread seed or fertilizer



What about for spraying?

- Aerial spraying of pesticides traditionally done by fixed-wing or helicopters with pilot onboard
- This is changing
- Spray drones very common in Asia.
 - 30% of ag pesticides in South Korea sprayed with drones.
 - 40% of Japans rice crop.
- In its infancy in the U.S.



Japan in the 1990's

- Yamaha
- Single rotor - small helicopter
- 10 ft diameter, 200+ lbs
- 4-gal spray tank capacity
- Gasoline powered
 - Can run about 1 hour before refueling
- FAA approved in CA in 2015
- Company does not sell aircraft, they service it and provide people to operate



Photos: Ohio Ag Net; turfmate.com

Advances in drone technology

- Rapid proliferation
- Lighter, easier-to-operate
- Lightweight but powerful enough to lift 10-15 gal tank
- Mostly multi-rotor types

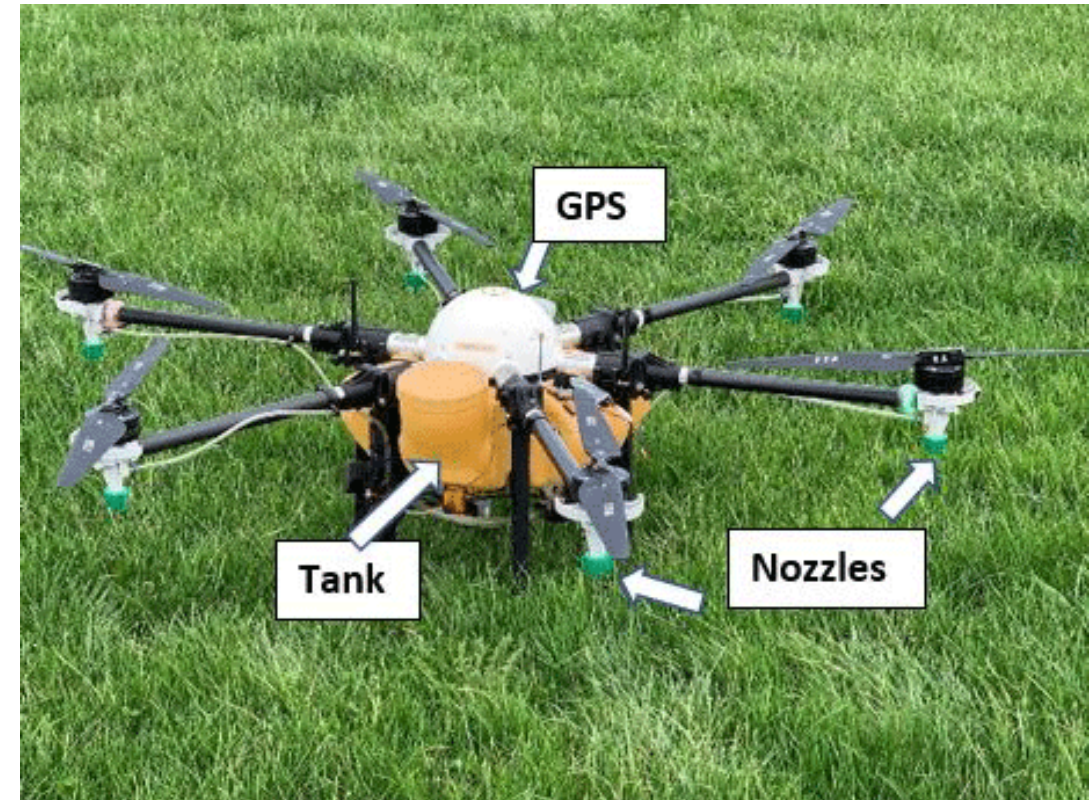


Multi-rotor drones are similar...but different

- All have a tank, pump, flow meter, hoses, filters, and nozzles

Differ in:

- Number of rotors
- Rotor positions
- Nozzle locations and configurations
- Type and number of nozzles
- Distance between nozzles
- Vertical distance between rotors and nozzles under them





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Photos: DJI Agriculture; Erdal Ozkan, Ohio St.

Controlled Droplet Atomizers (CDAs)

- Most use regular flat fan nozzles
- Newest design for spray involves rotary atomizers positioned under large propellers.
- Droplets produced by the rotational speed of a cup
- Allows spray mixture to be emitted using very low pressure
- Produces uniform droplets



Which one is best?



Operating characteristics

- Usually 2-5 GPA - Determined by chemical and application
- Spray about 10 feet above canopy or ground
- Spray 10-20 mph
- 20-30 ft spray width
- Spray approx. 40 acres per hour
- All have terrain sensor that maintains optimum flight height in hilly or uneven terrain
- Most are compatible with RTK
- Price \$20,000-\$40,000, depending on size, spraying capacity, manufacturer, and other features



Refill process

- Drone lands
- Pull battery out
- Fill it up
- Put in new battery
- Takes about 45 seconds



Photo: Top Crop Manager

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What licensing do I need to operate a spray drone?

- Two certifications from FAA
 - Part 107 Certificate – to fly a drone
 - Part 137 Certificate – to apply pesticides with a drone
 - Same rules and laws as aerial applicator
 - Used to require FAA to inspect hanger, aircraft, watch fly, fly with
 - Now easier - paperwork only.
- 55 + exception for drones
- State pesticide applicators license
 - Also need aerial endorsement



Where are drones the best fit?

- Fields with less-than-ideal conditions
 - Steep or uneven terrain
 - Obstacles (i.e., sprinkler pipe, trees, or power lines)
 - Wet soils
 - Mature crop canopy
- When airplanes and helicopters are not available
- Drones more efficiently spray small, irregular-shaped fields
- Fields where complaints are common
- Spot spraying weeds



Should I park the ground sprayer and go all in on the drone?

- No, drones do not replace ground rigs
 - Speed
 - Uniformity



Obstacles to adoption

- Not enough research data on how drone performance compares to conventional sprayers (efficacy and spray drift)
 - Data that is available may not be usable due to wide variation of design parameters of drones being tested
- Propellers pull droplets back into the down draft while blowing smaller droplets (fines) out away from the target zone.





Obstacles to adoption

- Uneven spray pattern
- Fines are prone to drift
- Don't have much tolerance for weed escapes or spray skips
- With a sub-optimal application, are we going to generate more resistance?



Obstacles to adoption

- Short life of battery pack (approx. 5 min with full tank).
 - Requires recharging during tank refills
 - Need 3 batteries per drone and fast charging at 240v to avoid interruptions (takes a 25,000 watt generator to fast charge 2 batteries)
- Need a spray base at edge of each field
- Spot spraying, variable rate spraying, or spraying a portion of a field is a 2-step process.
 1. Fly with drone with RGB or multispectral camera to map area to be sprayed.
 2. Upload map into flight plan of spray drone, which sprays when reaches appropriate GPS points as it flies over field



Obstacles to adoption

- Cover less land area per hour than ground or aerial alternatives
- “Swarm Spraying”
- Improved battery life
- Increased spray tank size



Photo: Adobe Stock

Obstacles to adoption

- FAA restrictions:
 - 55 lb weight limit including payload
 - Pilot must maintain visual line of sight with drone
 - FAA or tower clearance needed when flying in restricted airspace
 - Can only be flown from 30 min before sunrise to 30 min after sunset.
 - Can only fly one drone at a time.

***Can get waivers for 55 lb limit, night spraying, and line of sight



Obstacles to adoption

- Chemical product labels contain no information on drone spraying.
 - EPA allows drone use for spraying if pesticide is already labelled for aerial application and if FAA rules for operating drones are followed.
- 5 GPA or more for most aerial herbicide labels
- Propellers create turbulence in canopy
 - Significantly improves droplet penetration compared to traditional ground sprayers



Take Home Messages

- Will NOT replace ground or conventional aerial applications
- Any time you might use an aircraft, you can use a drone
 - Tall crop, wet soil
- Adoption rates will likely increase with changes in regulations and technology upgrades
 - FAA regulations on use of drones may be eased
 - Particularly restrictions on “swarming”
 - Improvements in battery life, wider swath width, higher flow rates, and faster operational speeds
 - Increased size of drones and spray tanks
 - Technology upgrades like variable-rate application, precision spot spraying and route planning, and better obstacle avoidance.



Thanks!

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