Pesticide Applications the Drone Way

Advanced Crop Advisers Workshop | Fargo, ND | Feb 12, 2025

Ag drones: a new*ish* technology.

Spray drones are emerging in the United States and North Dakota, but are established globally.

As of June 2024, drones have treated over 1 billion acres of land worldwide. There are currently over 300,000 agriculture drones working worldwide. 3.7 million acres were sprayed by drone in 2023, across 41 states and 50 crops.

In North Dakota, 69,032 acres were sprayed by drone in 2024, by 46 licensed pilots operating 37 registered aircraft for 21 unmanned aerial application owner-operators. This represents a nearly 600% increase in acreage from 2023, where 11,671 acres were sprayed by 6 licensed pilots operating 13 registered aircraft for 5 owner-operators. While the ag drone industry has grown rapidly in the state, it is still a small piece of the overall aerial application industry—5.4 million acres were sprayed by manned aerial aircraft in 2024. Nonetheless, unmanned aerial application seems to be meeting a niche, with a greater emphasis on herbicide applications relative to manned aerial application.

With the rapid growth of the ag drone industry, ensuring proper licensing of unmanned aerial applicators is an urgent need. Resources hosted on the ND Aeronautics Commission website (aero.nd.gov) outline the training and licensing requirements for unmanned aerial applicators in the state. This website also provides a directory of manned and unmanned aerial applicators who are licensed to operate within the state.

Example Use Cases

Devin Nohl shares experiences from his 5+ years of spray drone operation.

For a spray drone operator, following a few basic operational guidelines—regarding proper daily cleaning, maintenance, repair, and obstacle avoidance—is preferable to learning hard lessons.

Equally important is identifying suitable use cases for spray drones. Supported by images and video, Devin outlined several such use cases, such as weed control in pasture, fungicide application to row crops, pest control in aquatic systems, and seeding into standing crops. He also outlined logistical considerations, such as operator training, tendering, operating over uneven terrain, and operating multiple aircraft in a single field.

Evidence for Efficacy

Applied research within the U.S. and Canada provides examples of successful pest control with unmanned aerial applications.

The applied research literature is emerging for unmanned aerial applications in North America. Based on a limited survey of these studies, spray drones can seemingly provide similar outcomes as ground sprayers, even at much lower carrier application volumes (AV).

For example, an Enlist, Roundup and Anthem Maxx tank mix applied to soybean in Missouri achieved 68 to 75% waterhemp control with similar results between a drone sprayer (3 gpa AV) and a ground sprayer (15 to 20 gpa AV).

In Georgia, fungicide applied by a spray drone at 5 gpa AV and a ground sprayer at 15 gpa AV achieved equivalent leaf spot suppression in peanut, with no detectable difference in yield.

White mold suppression achieved through a fungicide application to soybean in Ontario was similar for a spray drone at 5 gpa AV and a ground sprayer at 16 gpa AV.

However, pest control efficacy in these studies trended higher at 5-6 gpa AV relative to 2-3 gpa AV, illustrating that the optimal AV for drone applications remains uncertain. Further complicating matters, the effect of AV on efficacy is influenced by weather conditions and drone operational settings, such as height over target and flight speed.

Calibrating for Success

Successful ag drone operations depend upon proper calibration, especially for swath uniformity and effective swath width.

Much like ground sprayers or manned aerial aircraft, spray drones must be properly calibrated. While describing a full calibration procedure (sprayers101.com/calibrate-drone) is outside the scope of this talk, we show images of two methods for measuring swath characteristics: water-sensitive paper and a continuous roll of receipt paper. The receipt paper method is more thorough and precise, but requires specialized equipment such as the Swath Gobbler (betterfieldstudies.com/swath-gobbler).

Spray drones tend to concentrate spray directly beneath the vehicle. Therefore, while calibrating, the operator should test different operational settings to minimize variability in coverage along the swath. The goal is to minimize this variability to the extent possible, as it is impossible to eliminate this variability.

Equally important while calibrating is to estimate the effective swath width. Research conducted in Canada (sprayers101.com/rpas-swathing-in-broad-acre-crop-canopies) found that the effective swath width of a DJI Agras T40 was reduced from a range of 26 to 27 ft in bare ground and wheat stubble to a range of 18 to 21 ft within wheat, soybean, and corn canopies, representing a reduction of 21 to 32% relative to bare ground. Although it may not be feasible to calibrate swath width within-crop, an alternative is to estimate swath width on bare ground or low-lying vegetative cover and adjust accordingly if spraying within a fully developed crop canopy.

About the Presenters

Rob Proulx

Rob Proulx is an Agriculture Technology Systems Specialist with North Dakota State University Extension. He has statewide responsibility for extension education efforts in agriculture technology, especially in the priority topic areas of precision agriculture, sprayer systems, and machinery systems.

Devin Nohl

Devin Nohl is the CEO of Tenacity Ag, a drone spraying technology supplier operating in the upper Midwest, responsible for customer relations.

Devin is also a farmer and has been a spray drone operator since 2020. Therefore, he has had a front row seat to the growth and advancement of the U.S. ag drone industry over the past five years.

Successful contact herbicide applications by drone...HOW???

Spray application principles may explain why drone applications of contact herbicides can be effective at application volumes of 5 gpa or less, even though 15+ gpa is recommended for ground applications.

Devin shared firsthand examples of successful dry bean desiccation with Sharpen and successful mid-season weed control with Liberty+glyphosate+AMS. This may be surprising, given that application volumes required for ground application are approximately three times greater than those for drone application, but these examples help to illustrate two important points about drone spraying operations.

First, research conducted in Canada suggests that, when applying low volumes of highly concentrated pesticide, deposit density is a better measure of coverage than % overall coverage. It seems that spray drones can provide a sufficient number of hits per area to achieve efficacy, even though overall coverage is greatly reduced.

Second, it seems that pesticide formulations may perform differently when more highly concentrated. Research presented at the 2024 ASABE Annual International Meeting showed that at a higher concentration (lower carrier volume) appropriate for drone applications, certain fungicides spread more effectively than at a lower concentration (higher carrier volume) appropriate for ground applications.

There is much to learn about how pesticide formulations and pesticide tank mixes react to the lower carrier volumes appropriate for drone spraying.

If the drone spraying industry continues to advance, and there is sufficient future demand, we can envision a future where pesticide active ingredients are reformulated to optimize their efficacy at the lower carrier volumes necessary for drone spraying operations.

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