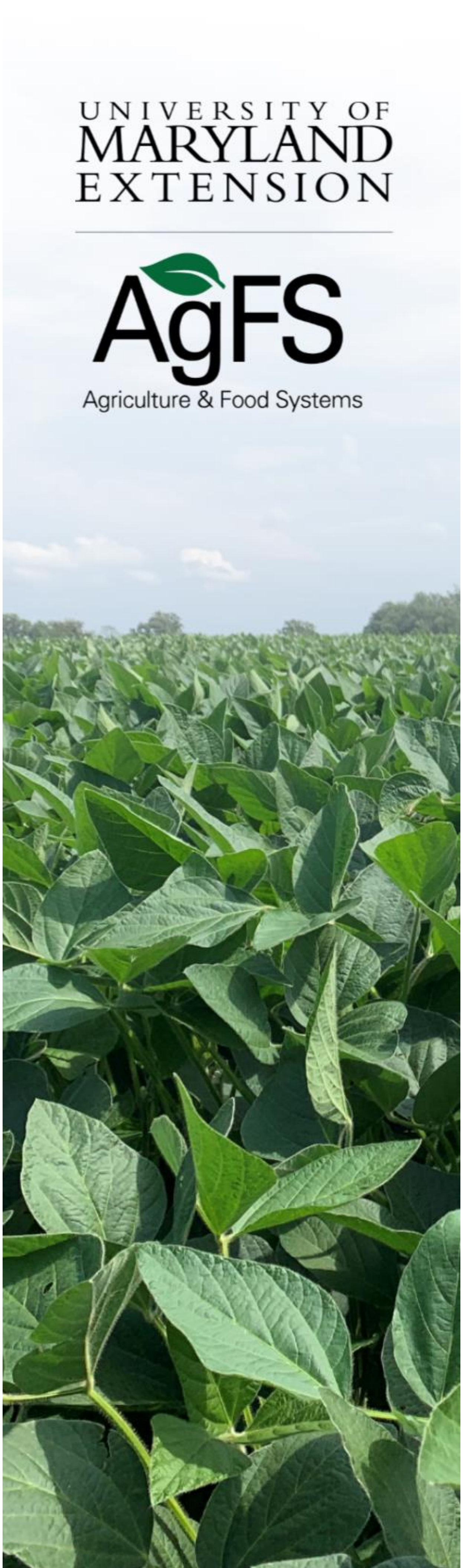

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Evaluating Efficacy of Aerial Pesticide Spray Applications Using Drones

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Justification

Drones are becoming increasingly popular in agriculture for not only imagery, but product application. As a result, startup companies offering aerial pesticide application via drone are emerging. Farmers have taken interest in the technology and service for several reasons, but the main benefit to using a drone to apply crop production products in soybean and corn is that it offers a feasible method for in-season foliar product application to fields that are smaller, fragmented, or irregularly shaped, without the potential for damaging the crop with a ground spray rig. Additionally, drones may have an advantage over helicopters or fixed-winged aircraft in small fields because they are more nimble and have the potential to achieve application to field edges that would be missed by aircraft. Finally, drones are much less intrusive to curious neighbors who often raise concerns when they see an aircraft applying products to fields.

Although drones offer a lot of potential, there is very little published data on their efficacy to apply products, which is cause for question and concern as to if drones are a viable and worthwhile means of applying products, such as pesticides, to corn and soybeans. Additionally, drones tend to lack spray tank capacity, so spray volumes with drone applications are low (1.5-2.5 gallons per acre). These low-volumes may pose challenges in achieving adequate coverage; however, products are applied at a greater concentration. This research project, funded by the Maryland Soybean Board, aims to collect data regarding drone spray efficacy in corn and soybean.

Objectives

1. Evaluate spray coverage achieved with drone application in soybeans and corn

Methods

A DJI drone (Figure 1) was used to apply water to standing corn and soybeans in fields located in Harford County, Maryland on September 13, 2021. Corn was planted on 30-inch rows and at the R4 growth stage during application. Full season soybeans were planted on 15-inch rows and at R6 during application.

The drone was operated by certified pilot who offers custom pesticide application in field crops and nurseries. Weather conditions were sunny and 87°F with variable winds out of the Northeast at 5 mph, gusting to 15 mph.

Figure 1. *DJI drone used for the project.*

Prior to spraying, water-sensitive cards (Syngenta AG®, Basel, Switzerland) were placed within the crop canopy at various heights in sets of five replicates. Two heights were used for corn (tassel: third leaf from tassel; ear: ear leaf) and one for soybean (top: upper most fully expanded leaf). When water droplets hit the card, the card arrests the spread of the droplet and stains the card blue. The cards were retrieved then scanned into the computer and analyzed using the software DepositScan (USDA-ARS, Wooster, OH), which calculates percent spray coverage, droplet density, and droplet size.

Two application volumes were tested for both corn and soybeans; they were 2.5 gallons per acre and 5.0 gallons per acre. The drone was equipped with TeeJet® TXA8002VK nozzles.

RESULTS & DISCUSSION

Figure 1 shows average spray coverage for corn and soybeans. Spray coverage at 2.5 gallons per acre yielded an average of 1.13% for corn tassel, with a minimum value of 0.08% and a maximum value of 3.12%. Average spray coverage increased slightly to 1.53% for the ear leaf, with a minimum of 0.16% and a maximum of 5.53%. At 2.5 gallons per acre, spray coverage in soybean ranged from 0.24% to 8.60%, with an average of 2.38%.

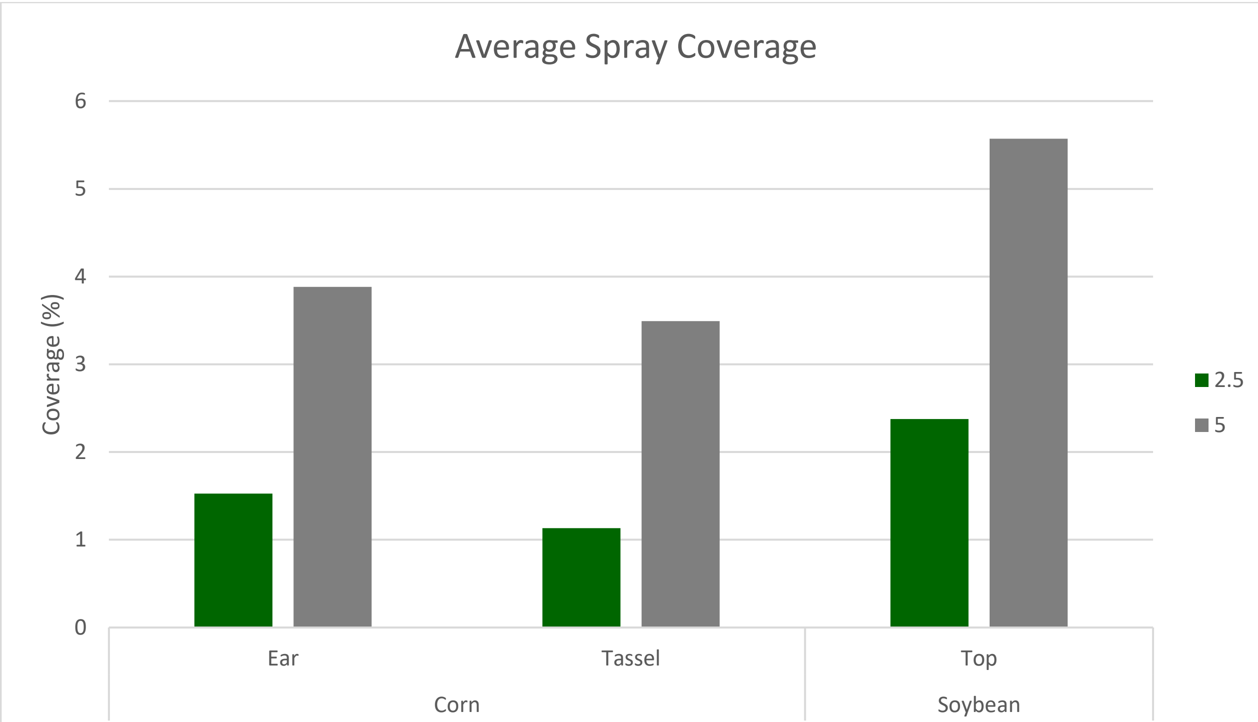

Figure 1. *Average percent spray coverage for water sensitive spray cards placed in the canopy of corn and soybean.*

As to be expected, applications made at 5 gallons per acre more than doubled spray coverage in both corn and soybeans. Average tassel and ear spray coverage in corn was 3.49% and 3.88%, respectively. Coverage ranged from 0.13-13.83% for the ear leaf and 0.73-7.97% for the tassel. Soybeans averaged 5.57% coverage, with a range of 0.04-25.52%.

Droplet density, a function of droplet size, is often used as an indicator of sufficient or insufficient coverage. A range of 20-70+ droplets/cm^2 is often a target for most pesticide applications, with the low end being sufficient for systemic products such as systemic insecticides, and the upper end needed for contact products, such as fungicides.

At 5.0 gallons per acre in soybean we observed an average droplet density of 45.1 droplets per cm^2. The tassel and ear leaf cards in corn averaged 29.6 and 33.2 droplets/cm^2, respectively (Figure 2). Densities were much lower with 2.5 gallons per acre, averaging 21.97 droplets/cm^2 in soybean and 9.80 droplets/cm^2 in corn tassel and 12.66 droplets/cm^2 in corn ear leaf.

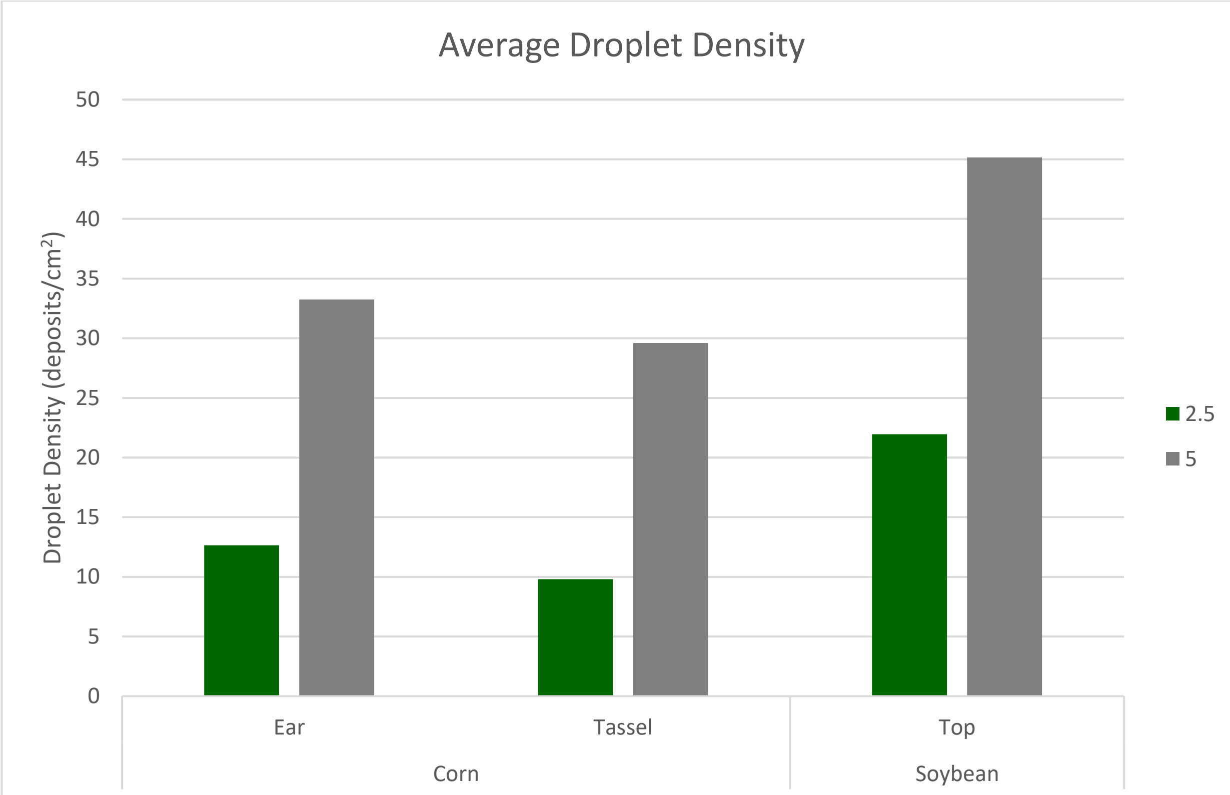

Figure 2. *Average droplet density on water sensitive spray cards placed in the canopy of corn and soybean.*

To achieve sufficient droplet density, it is generally recommended to spray most pesticides between 150-350 microns (µm). Droplet size is governed by nozzle type and spray pressure. Droplet size is determined by the droplet diameter (D) and the droplet volume (V). Volume median diameter (VMD) is the value where 50% of the droplets fall above and 50% of the droplets fall below. For example, VMD of 300 µm means that 50% of the droplets were less than 300 µm and 50% were greater than 300 µm.

The nozzles equipped on this drone for these studies were TeeJet TXA8002VK. The nozzles produced an average VMD of 275 µm at 2.5 gallons per acre application volume, and 288 µm at 5.0 gallons per acre (Figure 3). For most products, this falls within the acceptable range needed for proper spray coverage and product efficacy.

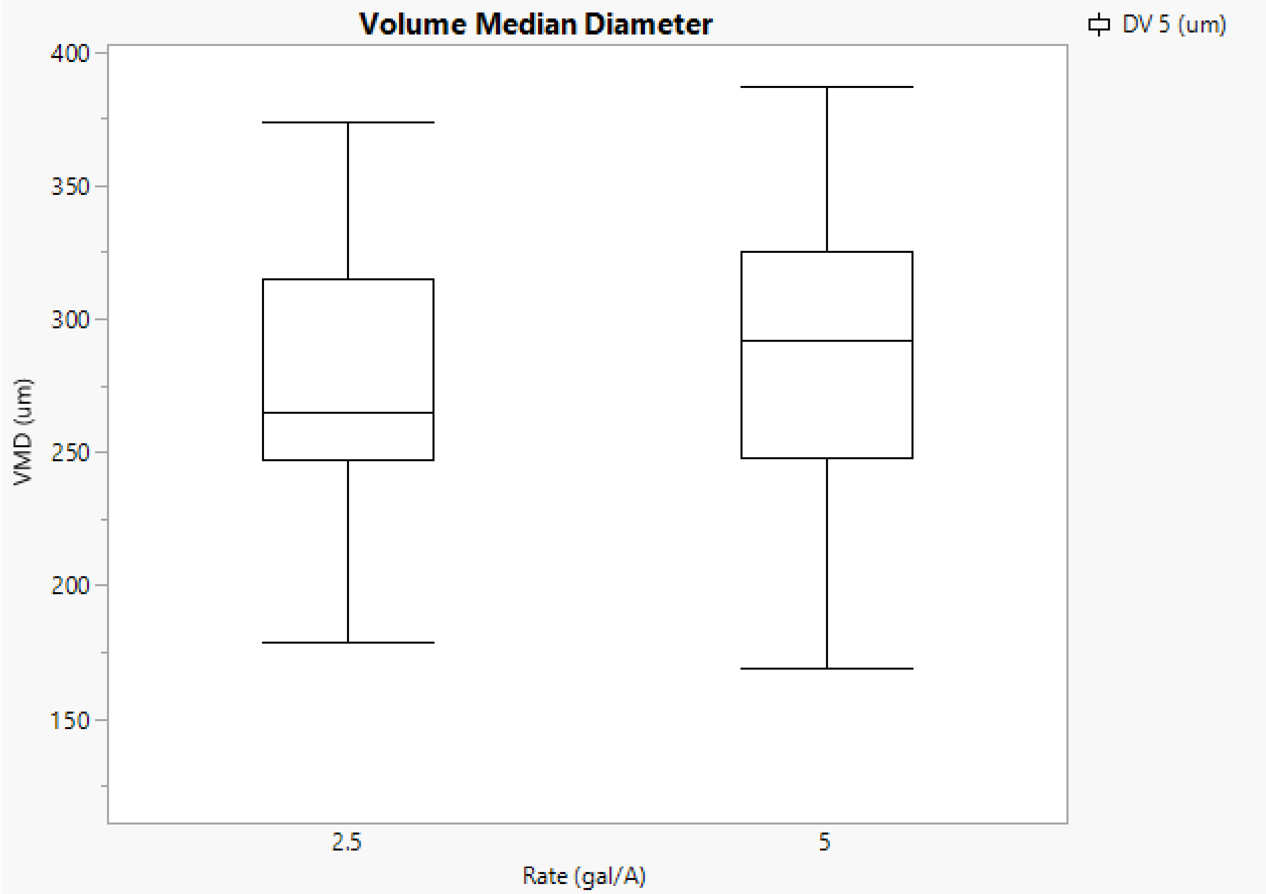

Figure 3. *Box plot showing distribution and volume median diameter (VMD) for spray droplets applied at volumes of 2.5 and 5.0 gallons per acre.*

Based on these data, applying pesticides via drones may be an effective method for pesticide application. Both 2.5 and 5.0 gallons per acre spray volumes produced VMD and droplet densities needed for pesticide efficacy. Application volumes of 5.0 gallons per acre achieved the greatest coverage, droplet density, and appropriate droplet size; being slightly better than applications at 2.5 gallons per acre. For products that need adequate leaf coverage, such as contact fungicides, spraying closer to 5.0 gallons per acre may be more effective than lower volumes or spray adjuvants included in the tank mix to maximize efficacy.

Future work will focus on conducting fungicide efficacy spray trials on corn and soybeans using drones.

Example Spray Card Images

Soybean, 2.5 gal/acre

Coverage: 3.51%
Droplet density: 37 droplets/cm^2
VMD: 260 µm

Soybean, 5.0 gal/acre

Coverage: 3.49%
Droplet density: 36 droplets/cm^2
VMD: 292 µm

Corn, tassel, 2.5 gal/acre

Coverage: 2.84%
Droplet density: 21.8 droplets/cm^2
VMD: 269 µm

Corn, tassel, 5.0 gal/acre

Coverage: 4.22%
Droplet density: 43.0 droplets/cm^2
VMD: 308 µm

Corn, ear, 2.5 gal/acre

Coverage: 1.35%
Droplet density: 10.9 droplets/cm^2
VMD: 283 µm

Corn, ear, 5.0 gal/acre

Coverage: 2.99%
Droplet density: 21.9 droplets/cm^2
VMD: 292 µm

ACKNOWLEDGEMENTS

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LITERATURE CITED

1. Hunter JE III, Gannon TW, Richardson RJ, Yelverton FH, Leon RG. (2020). Coverage and drift potential associated with nozzle and speed selection for herbicide applications using an unmanned aerial sprayer. Weed Technol. 34: 235–240. doi: 10.1017/ wet.2019.101