Awards issued prior to January 20, 2025, were funded under previous Administrations and may not reflect the priorities and policies of the current Administration.

United States Department of Agriculture
Project Initiation

Project Data for Accession Number 1026853

Project Title

Unmanned Aerial Vehicle for Pesticide Applications in the US

Project Details

Sponsoring Institution National Institute of Food and Agriculture	**Project Status** COMPLETE
Funding Source NIFA Non Formula	**Grant Year** 2021
Grant No. 2021-67021-35105	**Cumulative Award Amt.** $500,000.00
Proposal No. 2020-08911	**Multistate No.** (N/A)
Project Start Date Jun 15, 2021	**Project End Date** Jun 14, 2025
Program Code [A1521] Agricultural Engineering	

Project Director

Dodds, D.

Recipient Organization

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Performing Department

PSS

Non Technical Summary

Unmanned aerial vehicles (UAV) have been developed in support of precision agriculture to carry out timely site? specific pesticide applications with highly targeted spatial resolution and accuracy. Pesticide applications with UAV platform are increasingly becoming available in the US despite the scientific gap supporting this technology for pest management. Research investigating how to optimize spray parameters for UAV applications across different pest management systems in the US will accelerate the safe development and adoption of this technology in the US. The overall goal of this project is to optimize pesticide applications with UAV platform across different pest management systems in the US. This project will address the Engineering for Agricultural Production Systems area priority focused on (1) enabling engineering and automation for improving plant production systems; (2) developing and testing the implementation of tools and precision technologies for monitoring, measurement, and detection in agricultural systems that may incorporate both drone and unmanned ground vehicle technologies; and (3) developing and testing risk

assessment and mitigation measures applicable to agriculture. The overall outcome of this project directly addresses specific goals of the USDA: ensuring private working lands are conserved while improving water resources and promoting agricultural production by enhancing food security. This project is significant because broadcast pesticide applications are heavily scrutinized and the UAV technology could represent an option to timely spray pesticides in a precise and efficient manner. With the support of the USDA, the project team is ready to conduct this important project.

Animal Health Component

Animal Health Component: 0%

Research Effort Categories

Basic	20%
Applied	80%
Developmental	0%

Classification

Knowledge Area (KA)	Subject of Investigation (SOI)	Field of Science (FOS)	Percent
213	0210	1140	10%
213	1820	1140	30%
213	1710	1140	10%
213	1510	1140	10%
211	1820	3100	20%
211	1710	3100	20%

Knowledge Area

[213] Weeds Affecting Plants

[211] Insects, Mites, and Other Arthropods Affecting Plants

Subject Of Investigation

[0210] Water resources

[1820] Soybean

[1710] Upland cotton

[1510] Corn (for sweetcorn use 1480)

Field Of Science

[1140] Weed science

[3100] Management

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Keywords

UAV, precision agriculture, spray drift, Pesticide application technology, spray droplet size.

Goals / Objectives

The overall goal of this project is to optimize pesticide applications with UAV platform across different pest management systems in the US. Specific objectives for the proposed project:Investigate the droplet size distribution of different pesticide with candidate nozzles for UAV applications.Investigate how application technique parameters affect weed, insect pest, and aquatic weed control for UAV applications.Compare spray deposition and pest control of UAV applications to conventional ground and aerial application platforms.Establish guidelines on how to optimize UAV applications for pest control across diverse pest management system in the US.Communicate research findings through extension meetings, extension publications, social media, professional meetings, and scientific publications.

Project Methods

Dropet Size for UAV Applications:Extensive droplet size distribution data for UAV applications will be evaluated using a Sympatec Helos/Vario KR laser diffraction system (Sympatec Inc., Clausthal, Germany). The system has R7 lens that detects droplets in a range from 9 to 3700 ?m. Applications will be performed with different nozzles, operating pressure, carrier volumes, and pesticide solutions tested in this project. The DV0.1, DV0.5, and DV0.9, which represent the droplet diameter such that 10, 50, and 90% of the spray volume is contained in droplets of lesser diameters, respectively, and the percentage of the spray volume with droplets <150 µm (driftable fines) will be reported.UAV Herbicide Applications for Weed Control:Greenhouse studyThe study will investigate the potential of herbicide applications using UAV platform to control troublesome weed species such as waterhemp (Amaranthus tuberculatus), Palmer amaranth (Amaranthus palmeri), kochia (Bassia scoparia), and horseweed (Conyza canadensis). A series of herbicides will be tested including glyphosate, glufosinate, mesotrione, 2,4-D, and others. Following herbicide applications, plants will be kept under greenhouse conditions and will be harvested 28 days after treatments. Biomass data will be recorded and treatment comparisons will be performed using ANOVA with Fisher's least significant difference procedure. TField studyTreatments will be selected based on the preliminary results obtained with the greenhouse study and will include different nozzles, carrier volumes, and herbicides. UAV applications will be compared to conventional platforms (backpack and ground sprayer) with typical nozzle selection and carrier volumes as recommended in each herbicide label. Weed control (Palmer amaranth, Italian ryegrass, horseweed, etc) will be evaluated 28 days following treatment applications (visual estimations of injury, plant mortality, and biomass reduction). Tank solutions will include fluorescent tracer (PTSA or Rhodamine) for spray deposition detection. Mylar cards (Grafix Plastics, Cleveland, OH, USA) and water sensitive papers (Syngenta, Basel, Switzerland) will be used to collect spray deposition on weeds and at different canopy levels on soybean and corn. UAV Herbicide Applications for Insect Control:Laboratory studyApplication simulations will be performed in the laboratory to investigate the efficacy of insecticide applications using UAV platform to control soybean insect pests such as soybean looper (Chrysodeixis includens), green stink bug (Chinavia halaris), and marmorated stink bug (Halyomorpha halys). Insect colonies will be established in the Agroecosystems Entomology Lab (University of Nebraska-Lincoln, West Central Research and Extension Center, North Platte, NE). Insecticide solutions will be applied with the research-spray chamber calibrated to deliver selected UAV, ground, and aircraft spray deposition on different soybean canopy layers as reported in previous studies included in this project. Aircraft aerial and ground spray deposition on soybean will also be provided by Dr. Brad Fritz. Six petri dishes will be sprayed for each treatment. A group of 10 insects will be transferred to each Petri dish and mortality will be recorded 72h after infestation.Field studyTreatments will be selected based on the preliminary results obtained with the spray droplet study and will include different nozzles, carrier volumes, and insecticides. UAV applications will be compared to conventional platforms (ground application) with typical nozzle selection and carrier volumes as recommended in each insecticide label. Control will be evaluated 5 days after treatment applications. Target insect pests for cotton include thrips (Frankliniella spp.), cotton bollworm (Helicoverpa armigera), tarnished plant bug (Lygus lineolaris), spider mites, and others. Target insect pests for soybean include bean leaf beetle (Cerotoma trifurcate), green stink bug,

marmorated stink bug, redbanded stink bug (Piezodorus guildinii), Southern green stink bug (Nezara viridula), soybean looper, cotton bollworm, and others.Tank solutions will include fluorescent tracer (PTSA or Rhodamine) for spray deposition detection. Mylar cards (Grafix Plastics, Cleveland, OH, USA) and water sensitive papers (Syngenta, Basel, Switzerland) will be used to collect spray deposition at different canopy levels on soybean and cotton.UAV Herbicide Applications for Aquatic Weed Control:Refinement and identification of an optimal carrier volume and spray coverage for herbicides used to control water hyacinth.The invasive species, waterhyacinth (Eichhornia crassipes) will be collected from field sites and established in mesocosms. Using small research sprayers, equivalent herbicide rates will be applied to mesocosms at a range of carrier volumes to model the effect of diluent concentration and spray coverage on treatment efficacy. Optimal application parameters derived from this objective will be utilized in later objectives.Comparison of UAV nozzle types and carrier volumes to an operational standard for waterhyacinth control. Waterhyacinth will be established in mesocosms and treated with herbicide at a multitude of potential UAV carrier volumes and nozzle types. An additional treatment will be applied using standard operational equipment and application parameters for comparison purposes. This objective will identify whether UAV applications could improve, worsen, or have no effect on herbicide efficacy compared to operational standard techniques.Effect of herbicide chemistry on UAV-applied herbicides for waterhyacinth control.Waterhyacinth will be treated in mesocosms with either foliar-active only herbicides or both foliar- and water-active herbicide using three different application techniques to investigate the effect of herbicide chemistry and application technique on efficacy. Results from this objective will give insight to successful herbicide candidates for UAV applications in aquatic systems.Comparison of UAV and operational standard equipment for treatment of waterhyacinth under field conditions.Waterhyacinth will be established under field conditions at two population density levels and treated with either UAV or standard equipment at operational scales. This objective will be used to verify mesocosms findings in early objectives.Comparison of UAV and operational standard equipment for in-water treatments for variable-leaf watermilfoil control.Herbicide applications will be made under field conditions via UAV or boat for control of the submersed plant variable-leaf watermilfoil (Myriophyllum heterophyllum). Boat applications will consist of sub-surface nozzles on trailing hoses and UAV applications will be a surface spray. Results from this objective will indicate the utility of UAV application technology for submersed plant control.Spray Drift Potential for UAV Applications:Field applications with UAV platform will be performed testing different nozzle designs, carrier volumes, flight height, and flight speed. Each spray treatment will have at least eight replications. UAV applications will be conducted perpendicular to the wind direction with drift collectors placed parallel to the wind direction at different downwind distances from the treated area. Tank solution will include fluorescent tracer (PTSA or Rhodamine) for spray deposits detection. Mylar cards (Grafix Plastics, Cleveland, OH, USA) and water sensitive papers (Syngenta, Basel, Switzerland) will be used to collect in-swath and downwind drift deposition at 1, 2, 5, 10, 15, 20, and 30 m from the treated area. Environmental conditions (wind speed, wind direction, air temperature, and relative humidity) will be collected for each application using a weather station equipment (HOBO RX3000, Onset Computer Co., Bourne, MA, USA)?.