
Latest technology in specialty crop production…
Good coverage +
~ 0 drift

Unmanned Aircraft for Agricultural Spraying of Specialty Crops

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July 2013

Overview of current status:

- UAV development and deployment in the United States

- Regulatory process

- Commercial availability

- Suitability for specialty crops

- Testing protocol and results

- Future work

Overview of current status:

-UAV development and deployment in the United States

Significant interest in the ag sector.

UAV: “Dull, dirty & dangerous”.

(Bob Cabanya, UAS, Inc)

Primarily for inspection, asset tracking.

Hobbyist industry.

Overview of current status:

-Regulatory process

No commercial use of UAV's (2015).

Public agencies can deploy UAV's via the COA (Certificate of Authorization) process.

Self certify airworthiness.

Limited operations, areas, aircraft.

Overview of current status:

-Regulatory process

Must have pilot and observer with both passed FAA knowledge test for Private Pilot and Class 2 Medical Certificates.

Must file NOTAM prior to flight and notify Air Traffic Control.

Typical line of sight operation, daylight hours, VFR, > 5 nm from airport.

Overview of current status:

-Regulatory process

"Dropping of objects" prohibited.

Conducted a safety analysis of spraying water and was approved.

Have two operational areas in CA:

Napa grape growing area

Central Valley nut growing area

Commercial Product:

RMAX™ –

Yamaha Motor Company.

- 100 kg
- 2-stroke, liquid-cooled, 250 cc, 13.6 kW engine
- 3.1 m rotor diameter
- 16 l liquid capacity
- 3 nozzles (1 or 2 active) (Fine / Med-Fine cat.)
- 400 m line of sight ops
- 1000 hr life
- Remote control with visual, not autonomous operation

Specialty Crops:

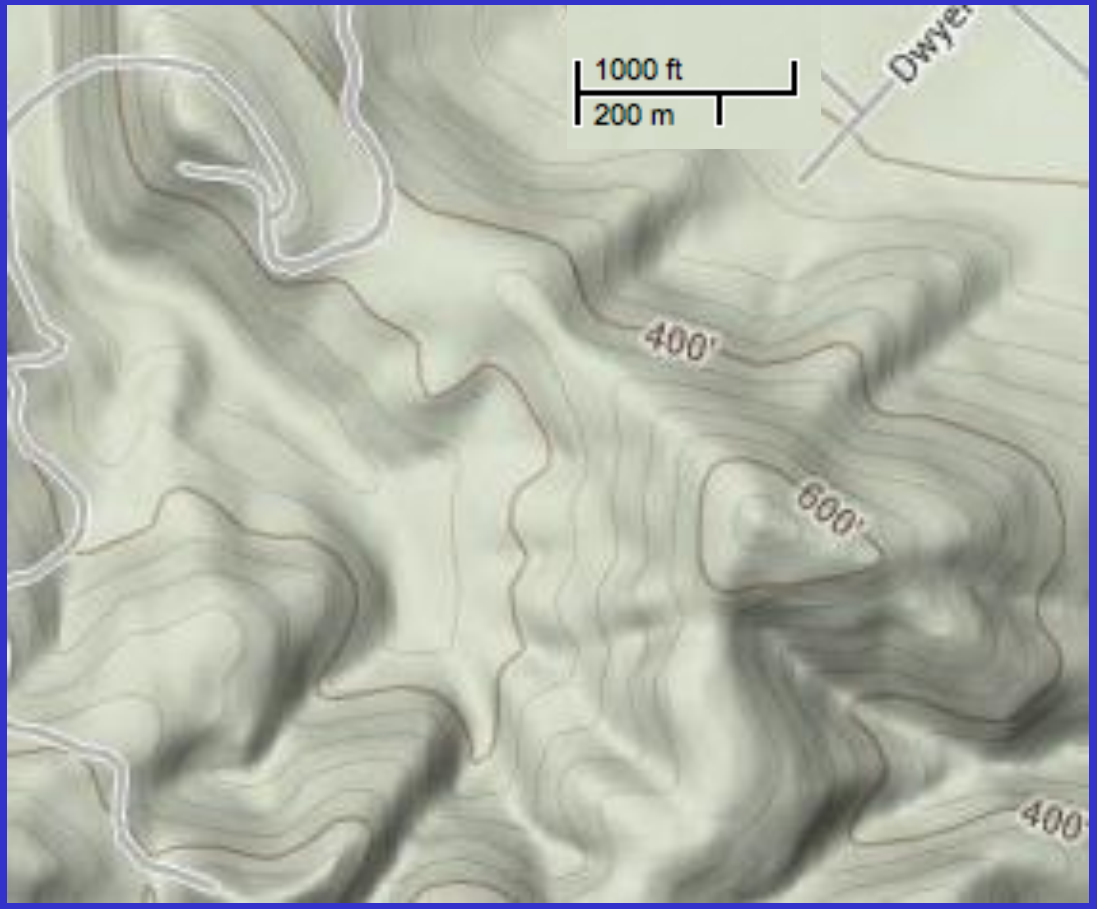
Small, complex fields
(45° slope)

Limited access during certain phases of season

Permanent plantings

High value

Season long spraying



Specialty Crops:

Specialty Crops:

Objectives of current project:

- Feasibility of commercial UAV for spraying?

  Physical suitability

  Spray deposition

  Productivity

Spray deposition:

COA allowed only water to be sprayed:

Water sensitive paper for sample medium

13 sample locations within canopy and on ground

Analyzed using Drop Vision AG

(Leading Edge Assoc.)

Spray deposition:

Application rates & productivity:

Productivity and application rate testing in a Cabernet Sauvignon block at the Oakville Field Station (UC) in Napa Valley, CA

Forward & downward video cameras on aircraft

Direct measurement of area and spray volume discharged

Spray, ferry, refill times observed.

Local meteorology recorded

Test Design:

Due to payload and spray pump constraints on aircraft, only method to adjust application rate was by swath width and number of passes.

Test Results:

Application rates

8 ft row spacing
8-10 mph ground speed

2 row swath x 2 passes	= 3.24 gal/acre
2 row swath x 1 pass	= 1.61 gal/acre
3 row swath x 2 passes	= 2.16 gal/acre
3 row swath x 1 pass	= 1.08 gal/acre

Test Results:

Field productivity

1.32 acres test block
200 ft length
1 -2 tank loads

2 row swath x 2 passes	= 3.06 acres/hr
2 row swath x 1 pass	= 6.12 acres/ha
3 row swath x 2 passes	= 5.13 acres/hr
3 row swath x 1 pass	= 7.35 acres/hr

Test Results:

Field deposition

Sample 3

Distance: 60.00 ft

NMD	107.17 µm
Dv .1	183.14 µm
Dv .5	343.16 µm
Dv .9	687.79 µm

Stain Count	583.00
Total Volume	3,316.01 nL
% Coverage	2.03
Relative Span	1.47
Nmd/Vmd	3.20

Replication 0

Drop Density	30.53 drops/cm
Volume Density	173.64 nL/cm or 1.86 gal/ac

Test Results:

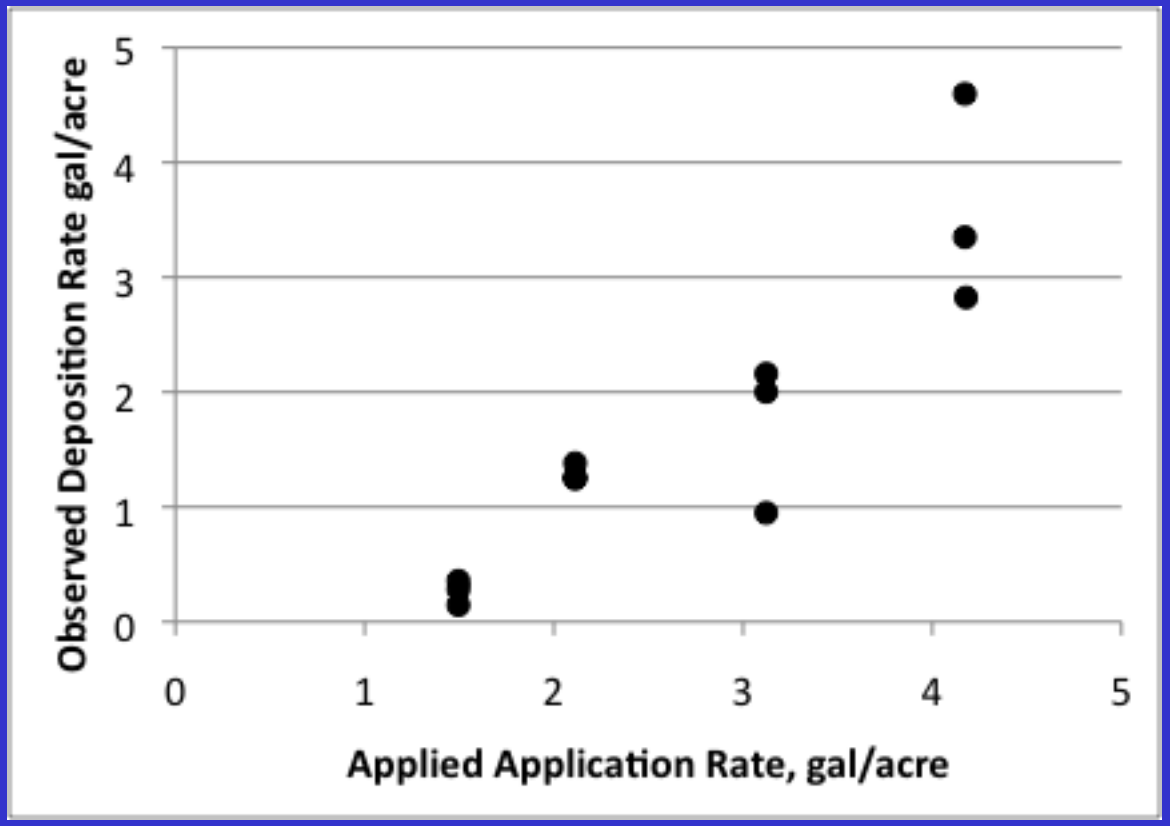
Field deposition

1.32 acre test block
200 ft length
1 -2 tank loads

2 row swath x 2 passes	= 4.92 (3.73) gal/acre
2 row swath x 1 pass	= 1.30 (1.14) gal/acre
3 row swath x 2 passes	= 1.70 (1.99) gal/acre
3 row swath x 1 pass	= 0.26 (0.19) gal/acre

Test Results:

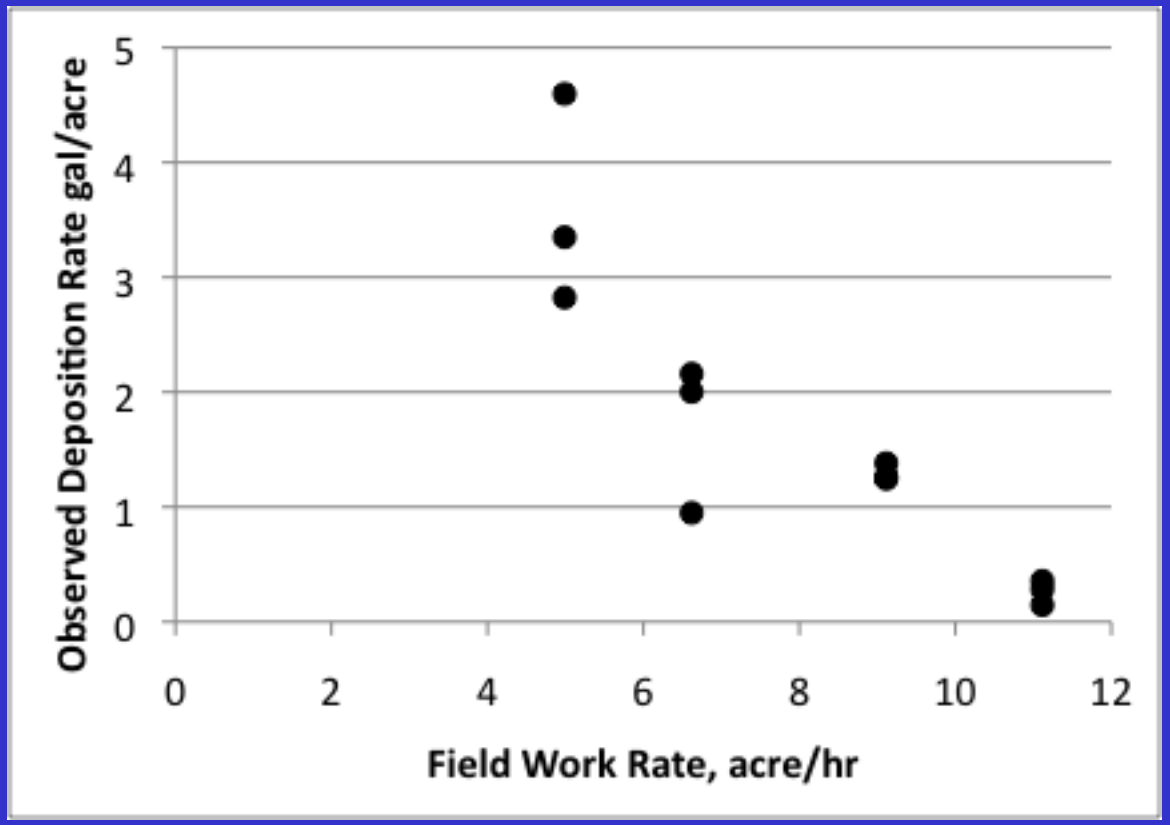
Field Deposition



Outliers trimmed

Test Results:

Field Deposition vs. Field Capacity



Outliers trimmed

Test Results: Swath Analysis

Test Results: Swath Analysis

+ / - 24 ft from CL spray cards

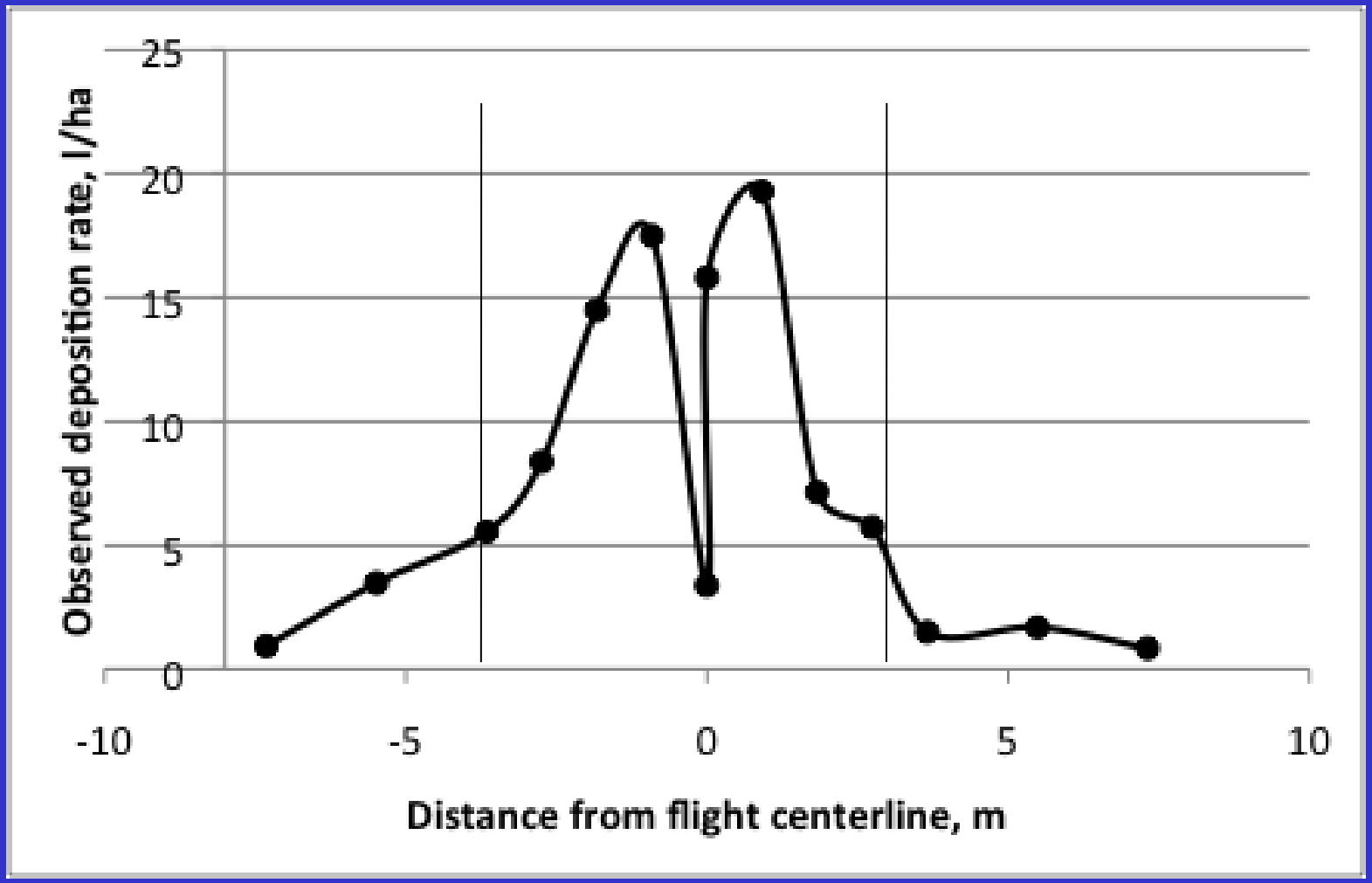
Ground speed average 8 mph

9 ft release height

12 replications

Winds 1 – 7 mph
+ / - 67°

Test Results: Swath Analysis



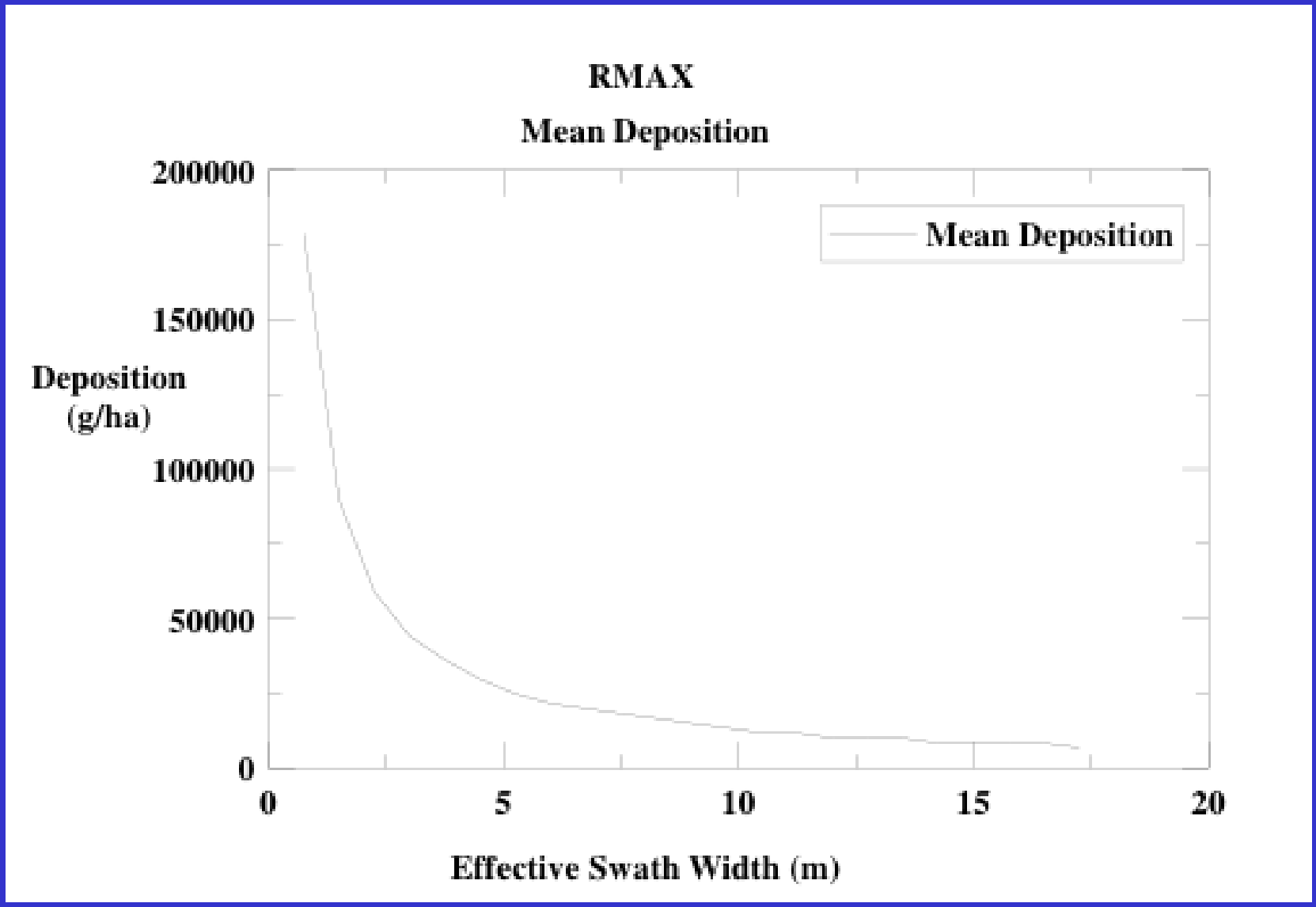
Winds 23° from left 3.1 m/s

Test Results: Model in AGDISP

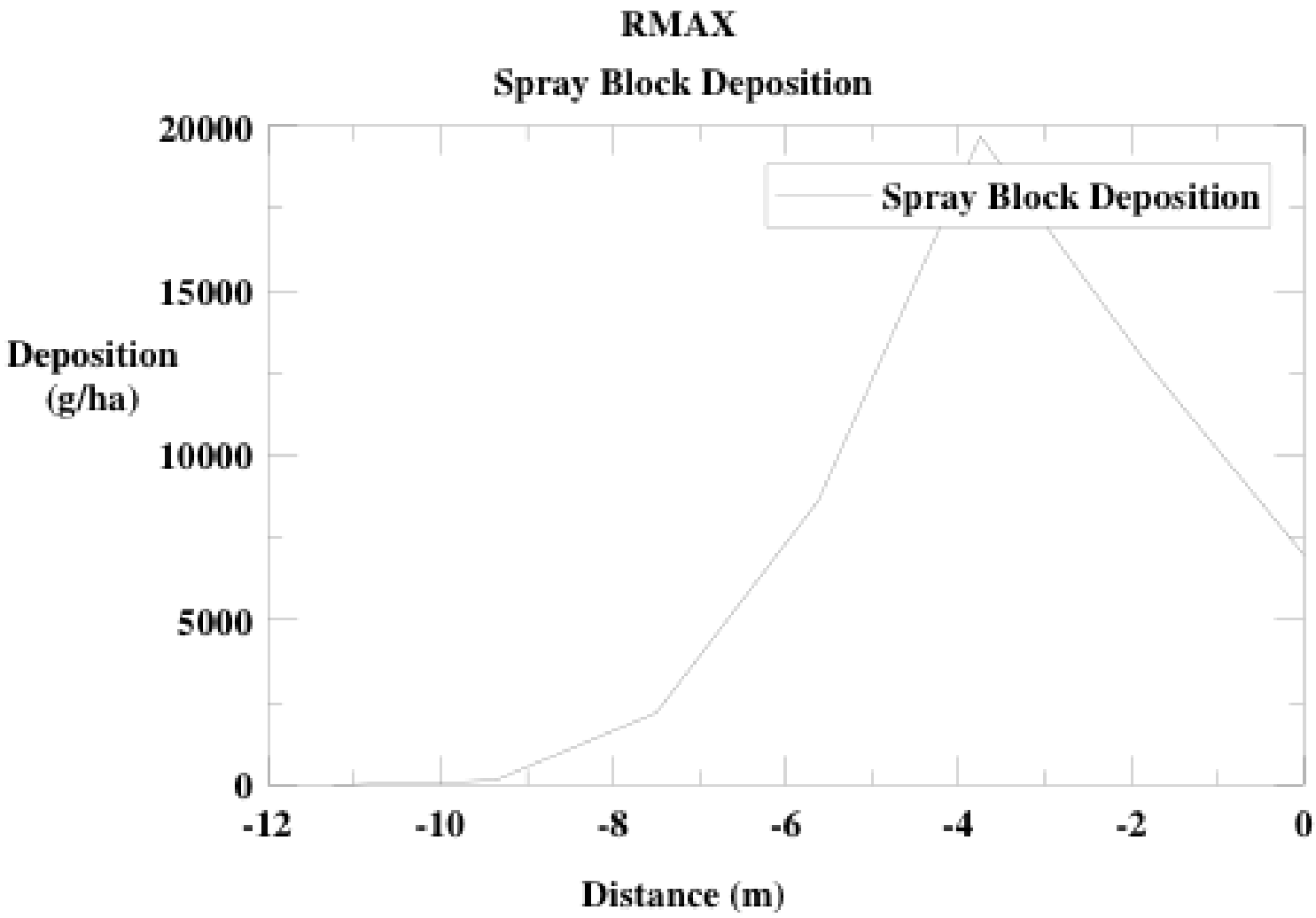
Many key parameters outside of model limits

Challenges: RMAX	AGDISP Limit	
Rotor Diameter	Min 3.58 m	1.79 m
Boom Vertical Disp.	Max -1.80 m	-1.00 m
Forward Speed	Min 17.88 m/s	3.55 m/s
RPM	Max 503	840
Weight	434 kg	100 kg

Test Results: Model in AGDISP



Test Results: Model in AGDISP



Conclusions:

UAV is a feasible spraying alternative to manned aerial application.

The tested platform (Yamaha RMAX™) is a low volume, small droplet size application.

Increasing application rate volume is challenging and not without corresponding decreases in field capacity (work rate).

Flight and vehicle parameters are outside the recommended ranges for AGDISP inputs.

Public acceptance of UAV-based spraying:

Texas restricts civilian drone usage, leaves exclusive rights to authorities

Published time: September 15, 2013 00:33
Edited time: September 17, 2013 11:20

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AFP Photo / Michel Comte

Public acceptance of UAV-based spraying:

FAA Warns Against Shooting Guns At Drones

By JOAN LOWY 07/19/13 05:40 PM ET EDT AP

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