American Society of Agricultural and Biological Engineers

An ASABE Section Meeting Presentation

Paper Number: AA08-006

Advantages of Reduced Application Volumes

Alan McCracken, 5611 NW 60th Street, Kansas City, MO 64151, USA

McCrackenAlan@aol.com.

Written for presentation at the
2008 ASABE/NAAA Technical Session
Sponsored by ASABE Technical Committee PM-23/6/2
42nd Annual National Agricultural Aviation Association Convention
South Point Hotel, Las Vegas, Nevada
December 8, 2008

Abstract. This paper deals with tests conducted with an applicator to improve the performance of agrochemicals for the control of rust in soybeans and corn with low volumes. Lower volumes are more effective for several reasons, however the most important is probably that the chemical ingredient is more concentrated enabling higher efficacy, such that one spray droplet may be adequate to kill a particular spore/insect. The tests illustrated the importance of the droplet spectrum in obtaining good coverage with low volumes is more important than the total volume of spray solution.

In seeking to obtain increased spray coverage, it is far more important and more economical to decrease the droplet size than to increase the spray volume. Data includes various spray deposition tests and the collection efficiency of inclined cards versus horizontal cards.

Reduced application costs due to higher productivity of the aircraft in terms of acres/hour, as less time is wasted refilling with water enabling spraying to be finished before mid-day when the weather is usually less favorable.

Keywords. Aerial application, low volumes, droplet spectrum different equipment, effect of volume on droplet size, advantages low volumes, spray deposition.

Introduction

The general thinking among most agriculturalists and entomologists is that for better coverage the applicator must increase the spray volume. Equally so many consider that when the crop is taller or denser that the applicator must increase the spray volume to maintain the degree of coverage of the foliage. This thinking is erroneous largely because of a lack of understanding of the mechanical aspects involved.

Example: A typical agricultural aircraft applying fungicides on corn.

Flying speed: 130 mph Swath width: 75 ft

Acres/minute: 130 mph x 75 ft / 495 = 19.70

Table 1.

Spray volume/acre	No of nozzles	Ideal No of nozzles	Flow (gpm) rate/minute/nozzle
1 gallon	40	40	0.49
2 gallons	30	80	1.31
3 gallons	30	120	1.97
4 gallons	30	160	2.62
5 gallons	30	200	3.28

Observations:

It is obvious from the above table that the dramatic increase in flow rate per nozzle will result in the creation of large droplets that result in inferior coverage. To maintain exactly the same droplet spectrum the operator should increase the number of nozzles, however this is obviously not practical

It is very easy to realize that to deliver the higher flow rates requires very large orifice sizes and consequently the production of a broad spectrum of large to very large droplets. These larger droplets impact the top leaves, bounce off and to a large extent end up on the ground between the rows increasing soil contamination.

Numerous researchers have demonstrated that smaller droplets penetrate the crop better than large droplets, therefore when the applicator increases the volume he invariably selects a larger orifice size on the nozzle with the consequence of increasing the volume of spray produced in large droplets.

From a technical standpoint it would be much more efficient to increase the number of spray nozzles, which would multiply the number of droplets and hence improve crop coverage.

Poorer coverage of crop and pests as large droplets fail to penetrate dense foliage often due to mechanical limitation in atomization since higher volumes normally mean larger nozzles that result in larger droplets.

Equally so with rotary atomizers when the flow rate is increased above their technical capacity they become "flooded" with high volumes and lose control of the droplet spectrum.

Objective

The objective of the study was to measure the effect of different atomizer speeds and also to evaluate the droplet spectrum collected and the effective swath width. The second phase was to evaluate an application of fungicide + insecticide applied to corn (*Zea mays* L. ssp. *mays*)and to compare the effect of the products on the droplet spectrum.

Materials and Methods

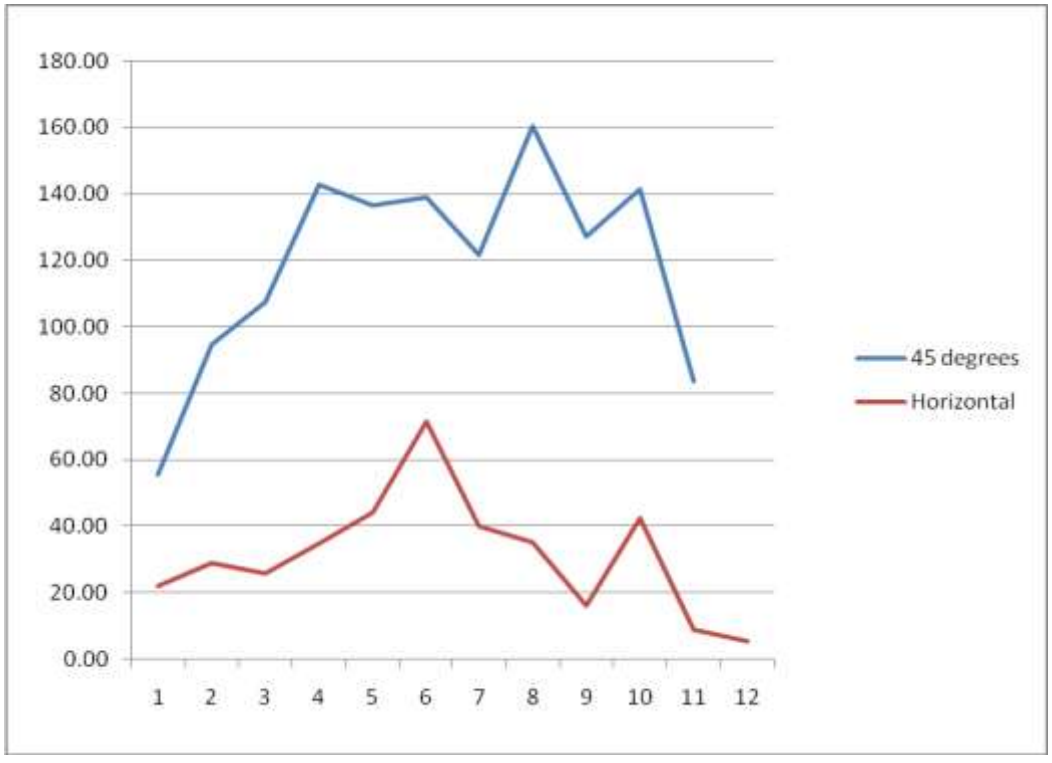
Tests were conducted using a Cessna AgTruck equipped with (8) MicroSpin rotary atomizers similar to the Micronair AU5000. Droplet deposition tests made flying into the wind, with collection papers positioned very (2) two meters. The spray droplets were collected using water sensitive cards (1 inch x 3 inches) and analysis made using the Stainmaster 1.0.9 program.

Test 1:

The aircraft was operated at a speed of 110 mph and a swath width of 18 meters with an application volume of 8 liters/hectare [0.86 gals/acre]. The rotary atomizers were set at position (3) for the production of medium to small sized droplets.

Comparison of droplet collection using horizontally placed cards versus cards inclined at 45 degrees to the prevailing wind.

Number of droplets collected per cm² [Average of 119 droplets/cm² on the inclined cards]

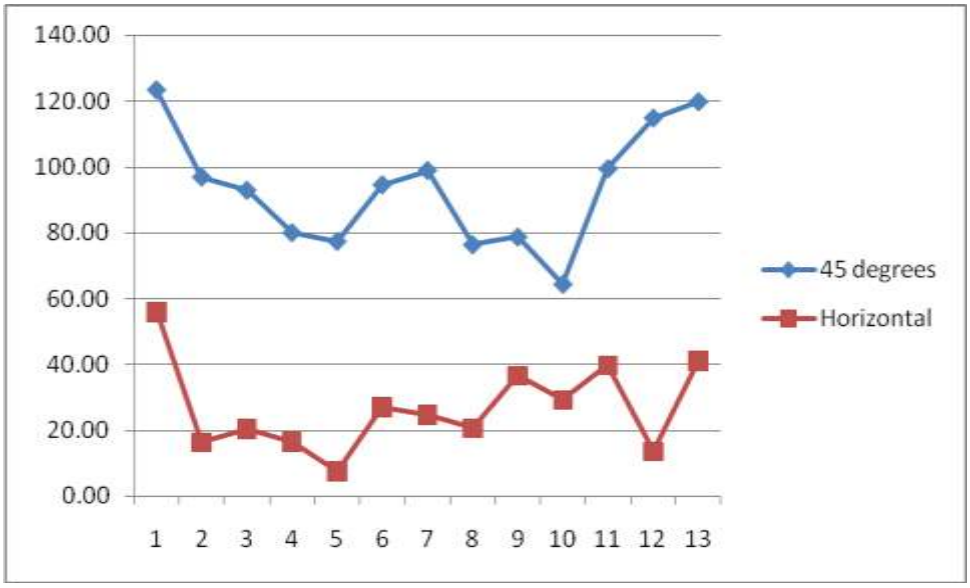


Observation: Very dramatic difference in the number of droplets collected comparing the efficiency of collection of the horizontally placed cards versus those positioned at 45 degree angle.

Test 2:

The aircraft was operated at a speed of 105 mph and a swath width of 18 meters with an application volume of 8 liters/hectare [0.86 gals/acre]. The rotary atomizers were set at position (4) for medium to small sized droplets.

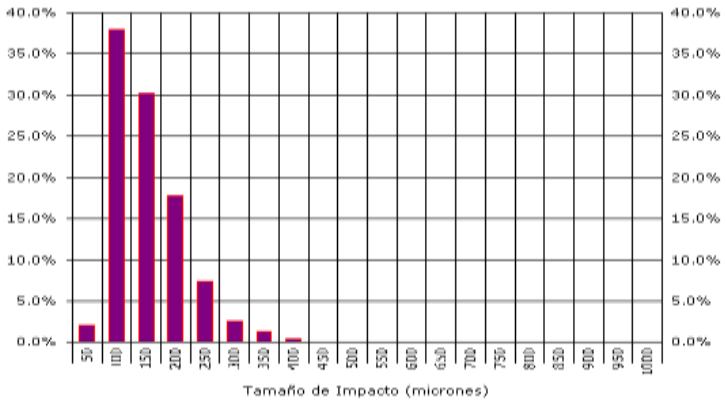
Number of droplets collected per cm²



Observation: The collection efficiency of the cards at 45 degrees was higher than those placed horizontally. Significantly fewer droplets colleted in comparison to test 1. due to the slower rpm of the rotary atomizers.

Table 2:

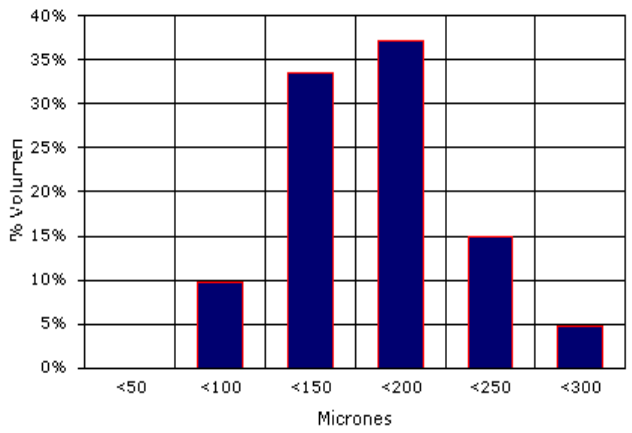
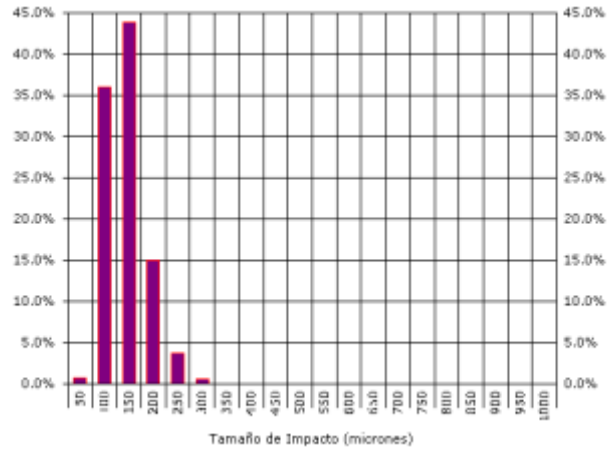
An example of the droplet spectrum produced with the rotary atomizers.

Blade angle 3


Observation: Only a minimal number of droplets collected under 100 microns and also very few large droplets with the largest being 400 microns. This is considered to be an ideal spectrum for contact acting fungicides and insecticides.

Importance of producing a narrow droplet spectrum tests made applying 8 liters/ha with Cessna AgHusky:

Table 3: Comparison histogram of (NMD) Number median diameter, with (VMD) Volume median diameter produced with the rotary atomizers.

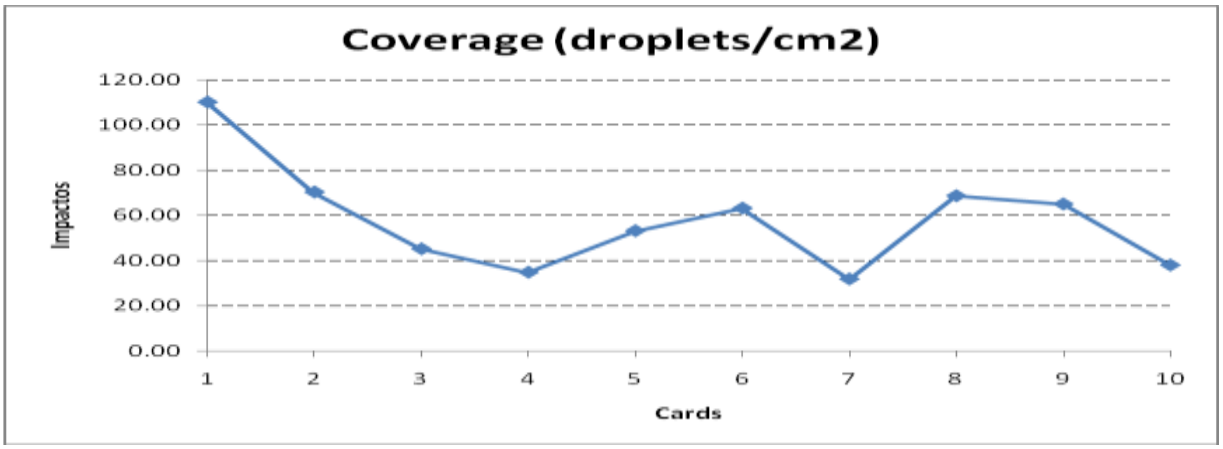
Droplet spectrum (VMD)	Droplet spectrum (NMD)
	

Observations:

Excellent narrow spectrum for maximum coverage yet with very few droplets under 100 microns.

Table 4:

Droplets collected during commercial application [average 58 droplets/cm² & VMD 114 microns]



Test 3:

The aircraft was operated at a speed of 110 mph and a swath width of 18 meters with an application volume of 12 liters/hectare [1.28 gals/acre]. The rotary atomizers were set at position (4) for the production of medium to small sized droplets.

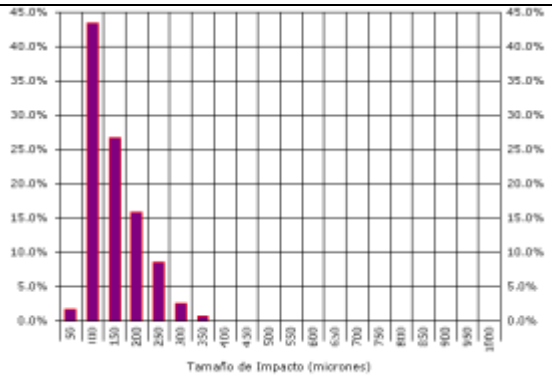
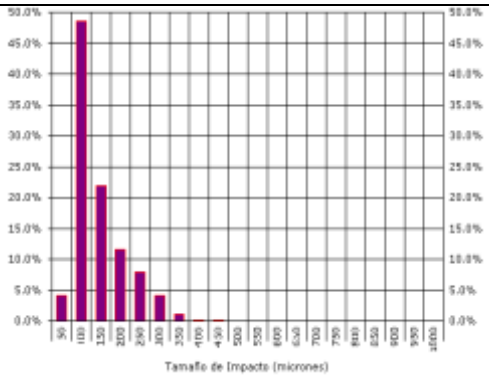
Products applied:

Fungicide (Azoxystrobin + Cyproconazole) + Insecticide (methamidiphos) + spray oil + water.

Crop: Corn 7 ft tall with an infestation of stink bugs both green and brown species and rust.

Table 5:

Effect of the addition of the fungicide/insecticide/oil on the droplet spectrum

Water	**Fungicide +Insecticide +Oil +Water**
	

Observation:

The addition of the chemical products increased the number of smaller droplets as expected due to the reduction in the surface tension caused by the presence of surfactants and the oil.

Conclusions

1. Effective swath width for the Cessna Agwagon was confirmed to be 18 meters [61 ft] for the application rate and droplet spectrum utilized in the test.
2. Collection papers inclined at 45 degrees to the prevailing wind had much higher collection efficiency [by a factor of 3- 5 times more depending on wind and droplet size] than those placed horizontally.
3. A spray volume of 8 -12 liters/hectare is sufficient to provide excellent coverage with 119 droplets/cm² collected when a narrow droplet spectrum is produced.
4. The commercial application using a spray volume of 12 liters/hectare provided excellent coverage as confirmed by droplet deposition and also with 100% control of the stink bugs (Acrosternum hilare & Halyomorpha halys) in the corn.

Acknowledgements

Terra Aviação Agricola, Cachoeira do Sul, Brazil

Pilot: Wagner Schoenfeldt Patta

Journal articles

Alan McCracken, AgAir Update, Terra Aviação Agricola, Precision, quality based on equipment testing. Volume 28 Number 2, February 2008

Alan McCracken . How can we increase the efficiency of Aerial Application?
Article 2 in a 4 part series. March, 2005
http://www.yorktonaircraft.com/0000pg.asp/ID/2786/SID/84

Alan McCracken Low Volume Spraying Better! - Guest Editorial Challenges Current Thinking January, 2005 http://www.yorktonaircraft.com/0000pg.asp/ID/2786

Alan McCracken Chemicals Perform best when properly sprayed." Custom Applicator, U.S.A. May 1986.

Alan McCracken "Increased Efficiency with [ULV] Contact action Requires Insect Contact" Agricultural Aviation. 21, No.1, January 1980