Minimizing effects of high temp, low humidity

Andre Textor of AeroTex in Brazil makes low volume application with rotary atomizers after adjuvant evaluation that minimizes effects of low humidity and high tempertures.

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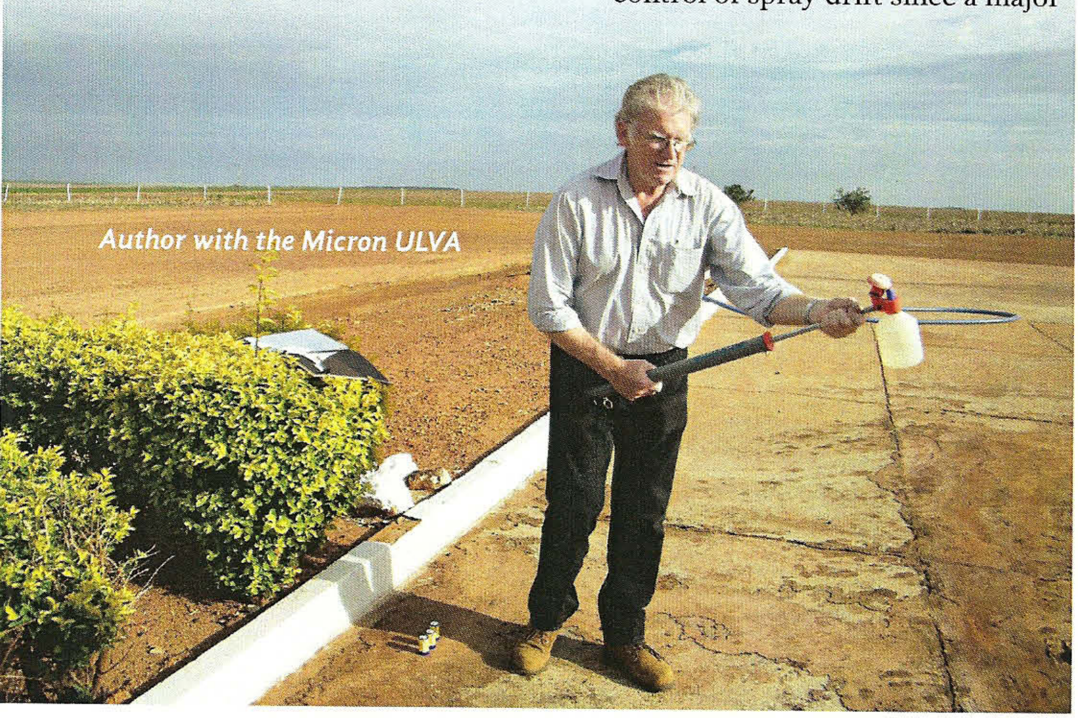
When working with agricultural aircraft on a hot dry day I often question the logic in loading an aircraft with water knowing that a very significant portion will never reach the crop due to evaporation losses, especially so when the product label specifies high volumes of 3-5 gals/acre. On many occasions when I applied sun protectant I observed that the whitish cream stayed wet for many hours even though it had some water, an invert emulsion. This observation led me to contact chemical suppliers searching for products that could be mixed in the field to form a stable invert emulsion with agrochemcials. This short report deals with some aspects of this development and potential benefits for aerial application with emphasis on improved deposition under hot, dry conditions.

As background, we should ask the question, "Why is Ultra Low Volume (ULV) application the standard for the most difficult pests in the world to control, namely mosquitoes, locusts, boll weevil and forest spraying?" The most evident reason is the ULV technique provides consistent and effective control. One of the main reasons why is because of control of droplet size, using non volatile formulations and suitable equipment that produce narrow droplet spectrums.

My question is, "Why do we insist on using water and even increased volumes of water in many cases, knowing that the water evaporates causing the droplet sizes to literally change by the minute due to evaporation losses?"

The researchers have invented fancy models to predict where the droplets might go. However, this is not practical since the rate of evaporation of each chemical mixture is different and hence droplet size will change dramatically with any change in temperature/humidity during the operation.

It's my opinion the use of water for aerial application should be restricted to conditions with low temperatures and high humidities, in all other applications we should use "non-volatile" carriers to ensure that the product reaches the target area. Only in this way can we expect to ever master the control of spray drift since a major cause of drift is the reduction in droplet size due to evaporation.



Author with the Micron ULVA

Several concepts have been evaluated including:

1. Addition of a non volatile carrier [glycerine] to the spray solution in a sufficiently high concentration to reduce the rate of evaporation. This option is very attractive for low volume applications and now in large scale usage in Brazil since the glycerine is easily mixed with most agrochemicals and is also much heavier than water.
2. Adjusting the amount of water in the chemical mixture to maintain a highly concentrated solution that is less volatile than water. Field experience under conditions of severe evaporation has demonstrated that a level of 15-20% of "non-volatile" component of the formulation is sufficient to provide adequate protection of the spray droplets against evaporation losses. For a total spray volume of 5 liters/hectare (5 gal/ac) this translates to 1 liter/hectare (1 gal/ac) of product + oil , either vegetable or mineral with suitable emulsifiers to produce a stable emulsion.
3. Preparation of an invert emulsion. This is a very promising alternative for low and ultra low volume spraying and two options have been evaluated, one based on mineral oil and the other utilizing soybean oil. These products were easily mixed and showed excellent stability for many hours with widely used fungicides and insecticides both SC and EC type formulations.

Equipment used for initial testing Tests conducted with a

MICRON ULVA battery powered rotary atomizer designed for the application of ULV formulations of insecticides/fungicides and widely used in developing countries. This hand tool is of great value since it produces a very narrow droplet spectrum and is easily adjusted for different droplet sizes by simply changing the number of batteries. The Micron ULVA sprayer was used to evaluate effects of different formulations on droplet size and evaporation losses.

Parameters of evaluation

1. *Ease of mixing invert emulsions* When the products were added to water and vice versa when the products were added to the chemical formulation a uniform creamy emulsion was formed immediately which did not cling to the wall of the sample bottle.
2. *Time to mark water sensitive cards:* During deposition tests using water sensitive cards, it was observed the droplets from the invert emulsion combinations took a much longer time to mark the cards than normally with water, showing the water content was secure within the oil.
3. *Time to dry on collection mirrors:* With all of the treatments, the droplets took much longer to dry on the mirrors confirming their effect on reducing evaporation losses.

Those of us who observe an application by air know it often takes between 5-10 seconds for the spray cloud to be deposited. In such a case, we could expect to lose 5-15% of the chemical product since the water based droplets will evaporate and drift to a neighboring farm, especially that fraction of the spray cloud in droplets under 150 microns, which could vary from 5-15%, or more.

Observations

In each case, the rotary atomizer produced a very narrow droplet spectrum as shown with the NMD:VMD ratio being very close to 1:1. When the number of batteries were reduced this resulted in a slower rotational speed of the rotary atomizer resulting in the production of larger spray droplets. As expected the lifetime of the droplets increased with an increase in droplet size.

When the "invert emulsions" were applied the droplets remained 'wet' for more than 30 minutes confirming a very low rate of evaporation, thereby ensuring that the droplets will reach the target crop or pest. The fact the product remains 'wet' should enhance the uptake of the product within the leaf. However, in one instance a heavy rainfall occurred just after the application that resulted in the product being ineffective since it was washed off the leaves.

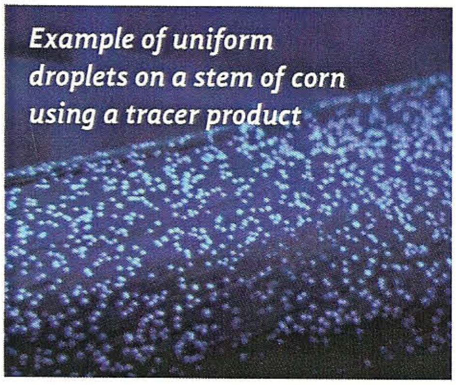
Tests with water

Temperature 28°C and 53% relative humidity with a wind speed of 5-8 kph

Number of batteries in the Micron Ulva			8	7	6	5	4
Water	Lifetime of droplets seconds		4	5	6	7	8
Drop sizes	water	VMD Microns	118	129	145	154	160
Drop	water	NMD microns	120	130	145	160	165

VMD: Volume median diameter, NMD: number median diameter.

Droplet analysis conducted using the Argentine program Stainmaster 1.2.7.



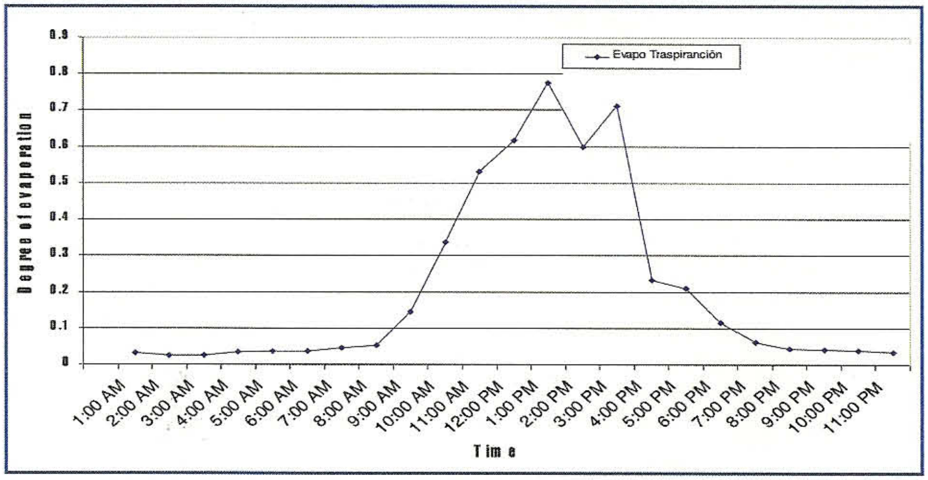
Further evaluations have driven me to adjust the chemical mixtures to ensure the spray droplets will reach the target and then dry to reduce the risk of wash-off. In most cases this can be achieved through using a non-volatile carrier. For example, with low volumes of 1 ltr/ha (3 gal/ac) fungicides .5 lts/ha + .5 lts/ha of the non volative carrier in an invert emulsion, then we can literally eliminate questions about temperature and relative humidity, since evaporation loss is no longer an issue.

By simple deduction, the droplet size produced by the equipment will then be the same size when they reach the target.

Observations

With an excellent narrow droplet spectrum of 98% of the spray volume between 100-350 microns, experience has taught us this is the ideal droplet spectrum for the control of difficult problems including soybean Asian rust and spider mites. Under conditions of high temperature and low relative humidity, one could expect to lose all the droplets under 100 microns through evaporation.

Wind speed There are many articles and product labels published that state for minimum drift to apply with little or no wind. The reality is the complete opposite. There is almost always a higher risk of drift under such conditions for two obvious reasons. If the spray droplets are hanging in the air they are subjected to greater evaporation losses resulting in smaller droplets that are much more prone to drift. Secondly, under such conditions there is a much higher risk of inversion conditions and these small droplets may then be carried long distances.



Flying height This is also another issue that is frequently debated among pilots and technical agronomists. Flying too high above the crop results in major losses in droplet size due to evaporation losses and also to crosswinds. Furthermore, flying too high results in loss of one of the major advantages of aerial application which is movement of the foliage enabling increased crop penetration. Have proven repeatedly that for the control of pests/diseases within the crops aerial application is greatly superior to ground application [2x] especially so at low wind speeds. Flying too low can also increases drift due to ground effect that forces the wind tip vortices high above the aircraft.

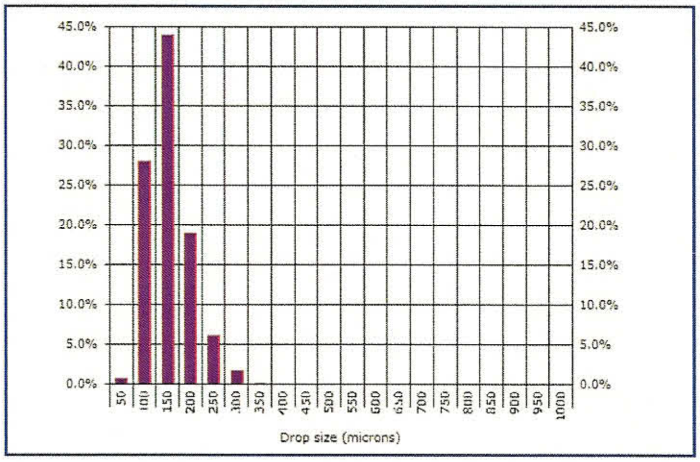
Equipment and control of droplet size This is the most critical issue and yet neglected by a large majority of operators who concern themselves more about foiling the volume of spray solution specified on the product label.

Drift control products In my experience these types of products can only make a positive contribution in reducing drift if all other aspects have been taken care of first. In such instance, they could be the icing on the cake. However, experience has also shown such products can greatly reduce the effectiveness of contact acting products, especially when spraying a dense canopy that requires smaller droplets to obtain adequate penetration.

Spray volume 5 liters/hectare; Rotary atomizers

Analysis of droplet distribution of water using water sensitive cards

Histogram of % of droplets by number.



Histogram of % of droplets by volume.