THE VALUABLE MISSING LINK

IN SPRAY APPLICATION DEPOSITION

dropsight

spray deposition tracer

imagine...

- Filling your car's tank and having to pay any charged amount without a meter on the pump.
- Paying for a pack of prime steak, without knowing what the weight is.
- Starting an extended road trip with no knowledge of the distances to travel.
- Getting to office in time without a watch.

Measuring has been the technology to base decisions on for centuries – without referenced and standardized measurement we are back in the dark ages and hunting for food, living in caves and fighting for daily survival.

MEASURING THE USE OF PESTICIDES IN AGRICULTURAL PRODUCTION

- Pesticides are defined as any synthetic, organic, or natural remedies like herbicides, fungicides, insecticides, foliar feeds, and growth regulators used in agricultural food production.
- Pesticide usage increased from 2,3 million Tons in 1990 to over 5 million Tons in 2022.
- Asia (52%), USA (30%) and Europe (14%) represent 97% of this usage.
- 47% loss in food production is foreseen if pesticide usage is terminated overnight.
- World food security is thus largely dependent on the responsible use of pesticides.

CONTAMINATION CAUSED BY PESTICIDES

- Food contamination caused due to excessive pesticide residue: "The Dirty Dozen" of food are perceived to be Strawberries, Spinach, Kale, Collard & Mustard Greens, Nectarines, Apples, Grapes, Cherries, Peaches, Pears Peppers, Celery & Tomatoes. Ask the consumers....
- Water and air contamination due to off target spray drift.
- Soil and ground water contamination due to excessive spray and consequent run off.
- The above have adverse effects on water, air, and soil quality, impacting on food quality, safety, and production, as well as biodiversity and human health.

All of this is largely as a result of the fact that we have not fulfilled all the requirements of the inverted **Responsible Pesticide Use Triangle (RPUT):**

When?

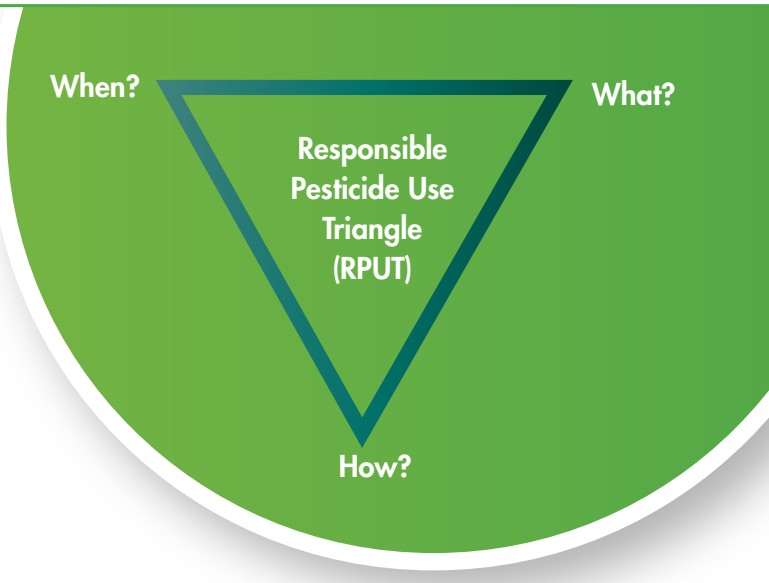
Optimized identification of target pest/disease/weed and timing of action using scouting information, weather station data, and disease modelling techniques.

What?

Correct selection of action to be undertaken & formulations chosen according to IPM and resistance management techniques.

How?

Assuring optimal spray formulation deposition on the primary target area with minimal off target spray.



Reliable in field spray deposition efficiency measurement techniques have eluded the industry for decades, and methods as crude as purely looking at the target surface area and judging the "wetness" or water sensitive paper clipped onto leaves or poles, and fluorescent pigment visually assessed by portable UV lights after dark in the orchard, all have the following in common:

- Non comparable, not measurable.
- Intuitive, quantitative, personal interpretation.
- No scientific base or reference.

- The balancing base point of the Responsible Pesticide Use Triangle (How?) has thus remained a non-quantifiable measure, leaving scope for personal interpretations and words like "full cover spray" or "good coverage" or "coverage to the point of run-off" have been used in spray assessments to set machinery up, on product registration labels to try at indicating a spray coverage requirement, and even in making claims or recommendations of the performance of spray equipment or chemical formulations.

- Spray machinery are "calibrated" to deliver certain volumes of **MIXTURE** per hectare, but at no point is there a **QUANTITATIVE** measurement done on the actual **DEPOSITION** of the **FORMULATION** achieved.

- When things go wrong, when the required outcome is not achieved, everything is critically evaluated and measured in the **RPUT**, **EXCEPT** the achieved spray deposition efficiency. For this we blame the "spray operator".

  This is unimaginable in 2023 – but sadly true.

THE AGRICULTURAL COMMERCIAL CROP PROTECTION CONUNDRUM

Billions are spent on agricultural remedies annually, 5 million Tons of chemical active is applied by spray machinery onto the crop to protect Trillions in crop value from pest and disease, but nobody really knows whether the formulation reaches and settles to the required deposition levels and uniformity on the intended target area.

WHAT IS SPRAY DEPOSITION EFFICIENCY?

Pesticides, Insecticides, Fungicides, Herbicides, Growth Regulators, Biological agents, and Trace element formulations, used in optimising crop quality and volume in commercial agriculture, are dissolved, or suspended in water at the required and predetermined concentrate/100 liter of water in the tank of a calibrated sprayer in preparation of applying it to the crop. This formulation could typically be a maximum of 2% of the mixture, depending on the combinations added in the tank.

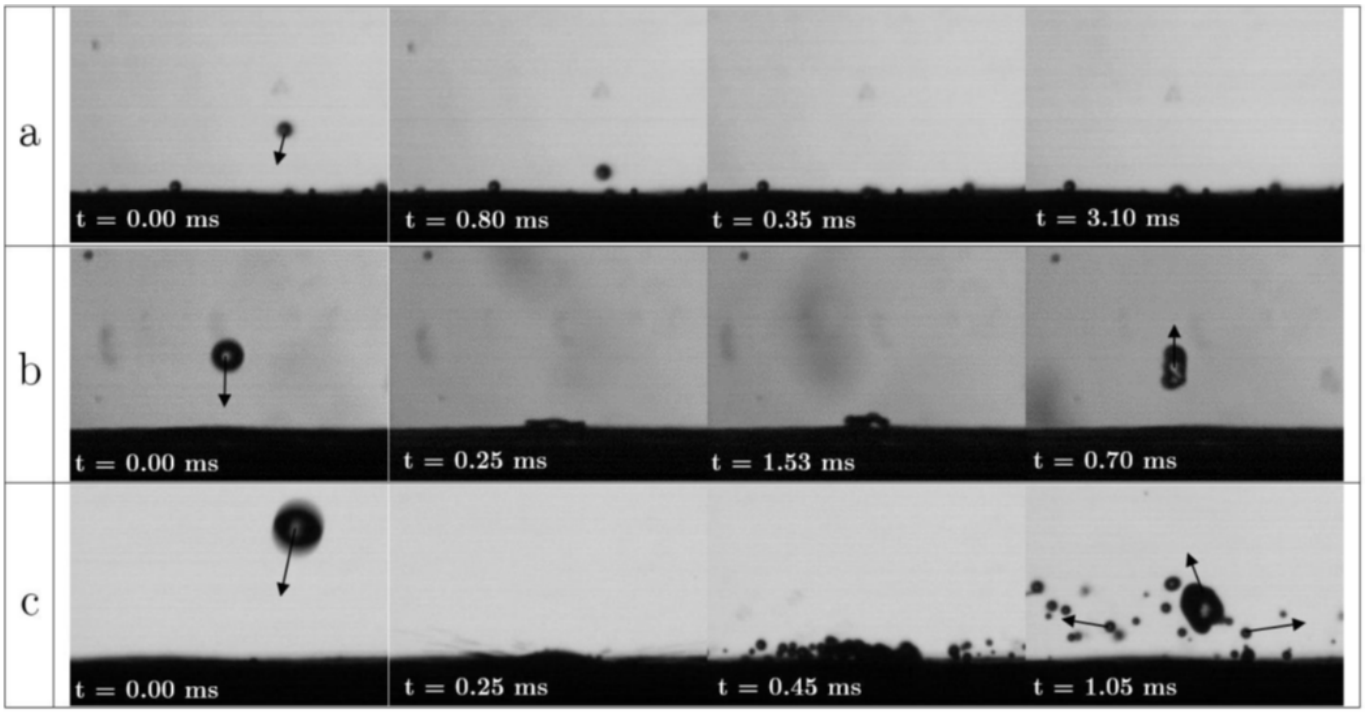
The primary reason for adding the required small quantity of formulation to large volumes of water in the tank, is to make the mixed volume easier to handle and distribute over the large target surface area of the crop.

To achieve a finely and evenly distributed mix of formulation & water over the total target surface area of the crop, the tank mix is atomized to an appropriately chosen VMD spectrum of droplets through hydraulic or venturi nozzles and distributed by hydraulic pressure or an air stream into the crop.

The formulation and water mixture droplets that impact on the target could do one of the following:

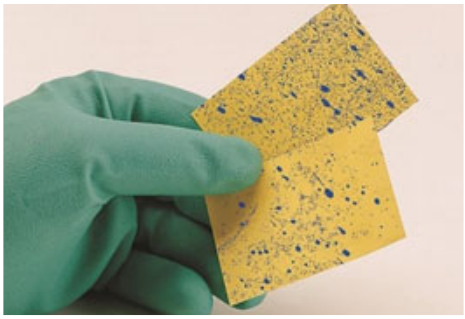
a. **Settle on the target = adhesion. 100 – 150-micron VMD have an 85% chance of settling on first impact.**
b. **Bounce back and deposit elsewhere. 200 – 250-micron VMD have a 55% chance of settling on first impact.**
c. **Impact, explode, bounce & partly settle. 350 + micron VMD has a 15% chance of settling on first impact.**

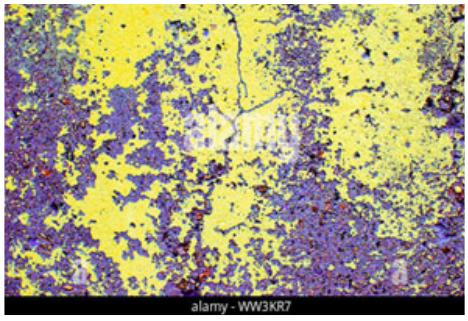
This is determined (amongst other things) by the formulation mixture, droplet size, impact angle & speed, as well as the physical characteristics of the natural surface target area like a dry cabbage leaf. (Mathieu Massinon et al, Crop Protection 99 (2017)):



- If **WATER SENSITIVE CARDS** were used instead of evaluation on a natural surface, the loss of coverage from first impact by bounce (15% loss in a, 45% loss in b and 85% loss in c above) and run off will not be reflected since the **WATER** in the droplet reacts **CHEMICALLY** with the card and produces a stain – regardless whether the droplet would have bounced off the natural target partly or completely, or run off has occurred.

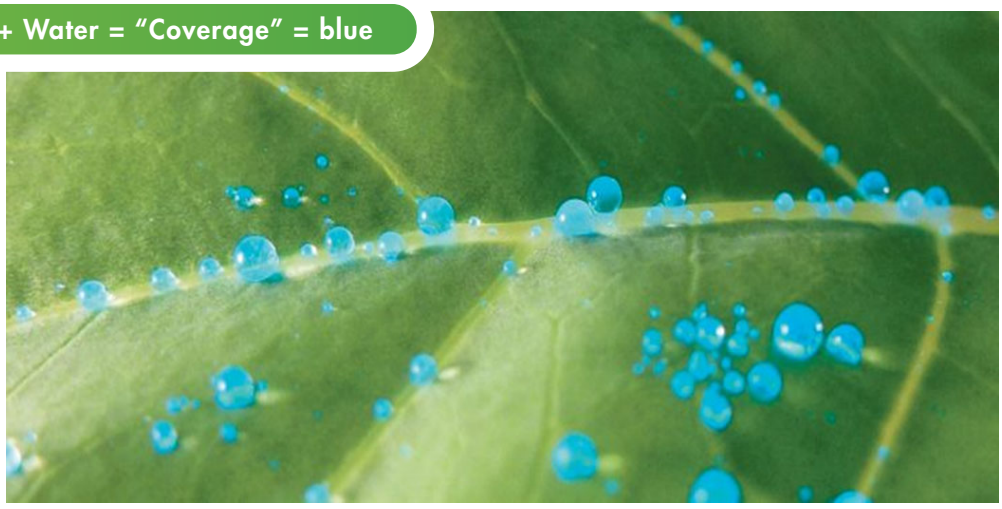
- Add to the above the unnatural and unknown spread factor of the water on the card, the different brands manufactured, and the effect that environmental humidity has on the spread, one can be assured that water sensitive cards will thus always **OVER INDICATE** "coverage" of the **MIXTURE** by a large margin.





The settled droplets on the **NATURAL** target surface area are the only contributors to the "coverage" achieved by the **MIXTURE**

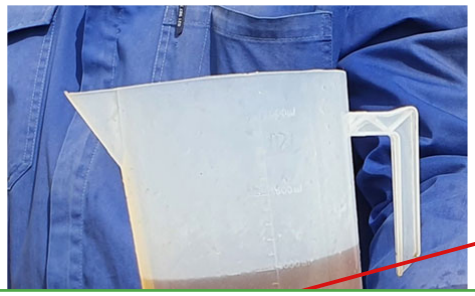
Formulation + Water = "Coverage" = blue



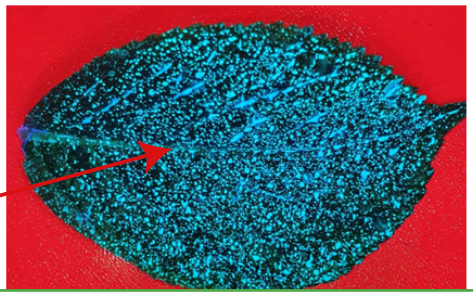
- The **CONCENTRATE** of the **FORMULATION** in these droplets is similar but slightly higher to the initial tank mix concentrate, due to the evaporation that occurred of the water on its way to the target. The **FORMULATION** is responsible for the chemical/biological activity, and is only a small (less than 5%) part of the **MIXTURE**.

- To form an opinion of the **DEPOSITION** of the **FORMULATION**, one thus needs to evaluate the deposition of the **TRACER** representing the **FORMULATION** on the natural surface of the primary target area, once the water has evaporated from the **MIXTURE** in the droplet.

- Using a completely water-soluble tracer in a pre-determined tank concentrate will thus more accurately represent the **DEPOSITION** of the **FORMULATION**.



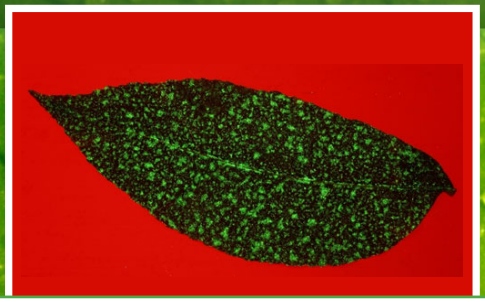
Water-soluble Tracer into Spray Tank



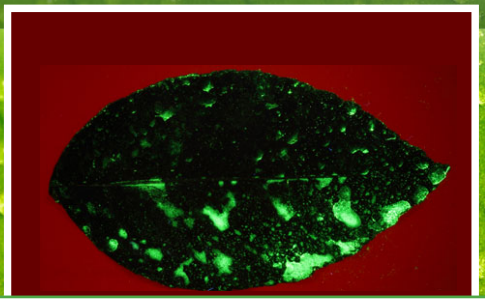
Water evaporated = only Tracer on surface = Formulation deposition simulated more accurately

This is the DEPOSITION EFFICIENCY achieved, and reflects the:

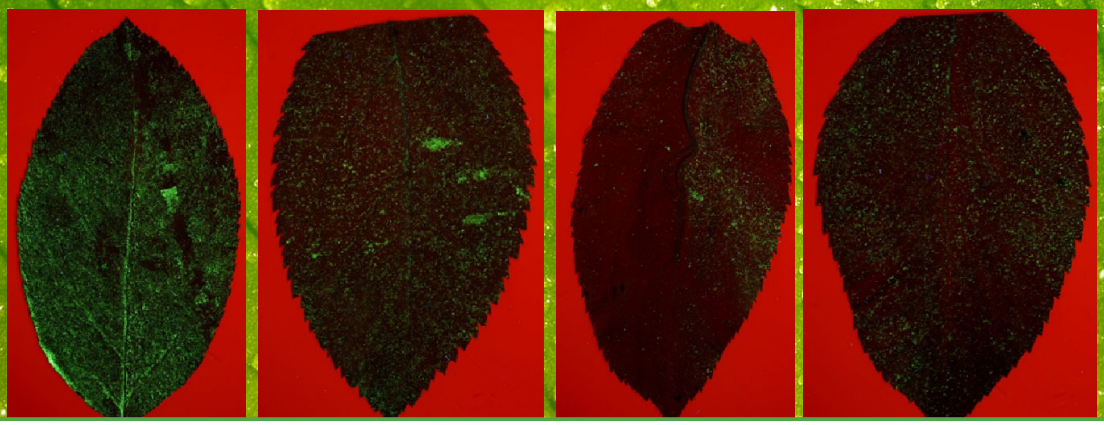
- **QUANTITY (FPC%) of the FORMULATION remaining on the natural target.**
- **QUALITY of distribution of the FORMULATION on the natural target area.**
- **UNIFORMITY (STD Deviation) of distribution of the FORMULATION throughout the natural target area.**



Good QUANTITY & QUALITY



Good QUANTITY, Bad QUALITY



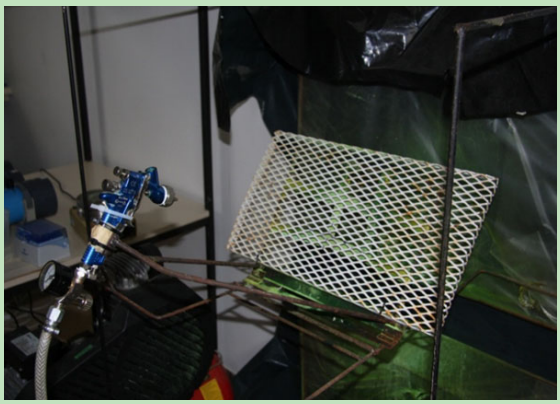
UNIFORMITY (Standard Deviation) indicates the consistency of deposition throughout the primary target area

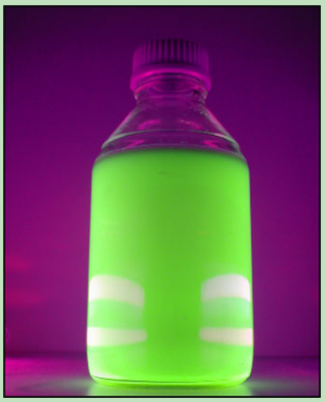
THE PHYSICS OF PROGRESSIVE INCREASE IN VOLUME ON DEPOSITION

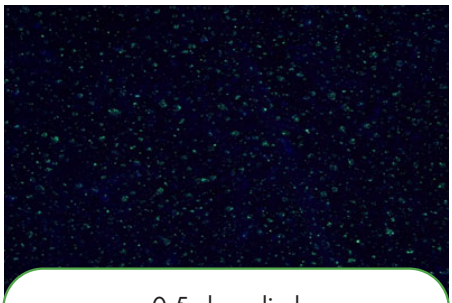
(Acknowledgement to the Department of Plant Pathology, University of Stellenbosch)

When applying a suspension concentrate (SC) of the fluorescent tracer SARDI YELLOW, which simulates the physical characteristics of copper with more than a 99% correlation, whilst:

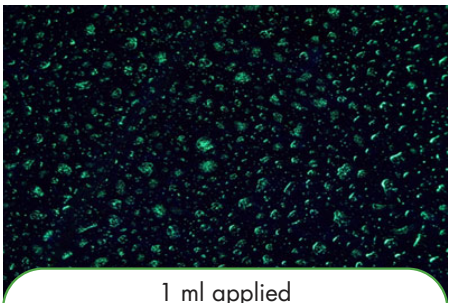
- Using a standard concentrate and the same FINE droplet spectrum category.
- In controlled conditions, sprayed onto a Vineyard Leaf on an inclined plane simulating the natural position.
- Increasing the volume applied by increasing the time sprayed to the target.
- Observing the progression of deposition as the applied volume is increased.



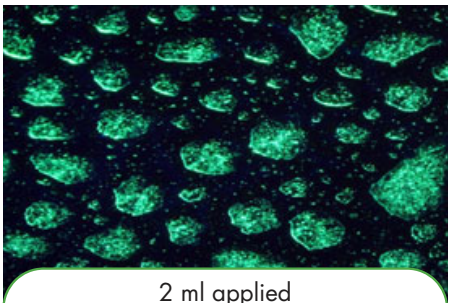




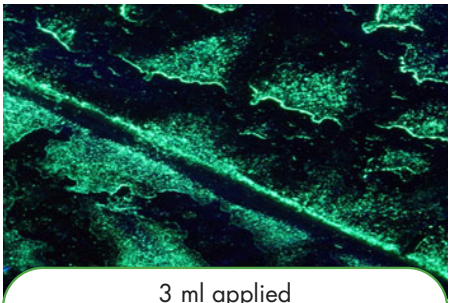
0,5ml applied



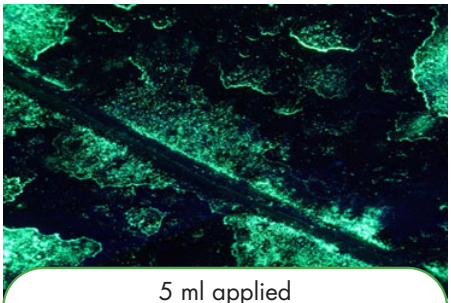
1 ml applied
Hydrogen forces initiate accumulation



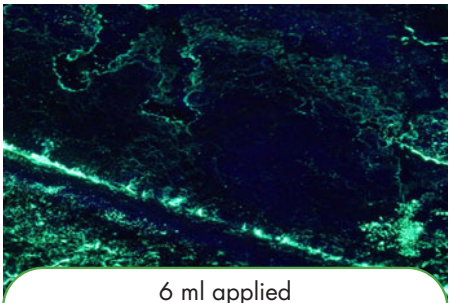
2 ml applied
Accumulation continues



3 ml applied
run off sets in



5 ml applied
free run off – "DRENCH"



6 ml applied
excessive run off

1. 0,5 ml applied: The **FINE** droplet spectrum is deposited with high **QUALITY** onto the natural surface, water evaporated and the formulation remains intact on the leaf surface.

2. 1 ml applied: The **FINE** droplet spectrum now starts to deposit more densely on the leaf surface, overlapping droplets and touching droplets experience the hydrogen forces in the water to accumulate the droplets and formulation into larger "pools" and thus creating open spaces in between. The **QUANTITY** of the deposition of the formulation is **INCREASED** and the **QUALITY** of the distribution is still **GOOD**.

3. 2 ml applied: The accumulation of the droplets continues due to the cohesive and hydrogen forces, the adhesive forces between the leaf and the droplet pools still maintain the formulation, but shows signs of excessive accumulation on the bottom perimeters of the "pools". Gravitational forces and adhesive forces are now at the "point of run off." The **QUANTITY** of deposition still **INCREASED** but the **QUALITY** has **DETERIORATED** and large areas of no formulation deposit is created.

4. 3 ml applied: The additional accumulation and subsequent growth of the "pools" result in gravitational forces now exceeding the cohesive forces, and run off sets in. The **QUANTITY** as well as the **QUALITY** of the deposition becomes **WORSE**. It is to be expected that the biological outcome will be impacted negatively. The risk of excessive accumulation on the lower perimeters of the leaf/fruit would increase the risk of undue residue levels detected or even phytotoxicity experienced from this point onwards. Formulation waste, ground and ground water contamination is a given from this point onwards.

5. 5 ml applied: Free run off occurs. Only applications of formulations with a physical mode of action, like Oil prays to control Scale by suffocation, should benefit from this type of application.

6. 6 ml applied: Excessive run off.

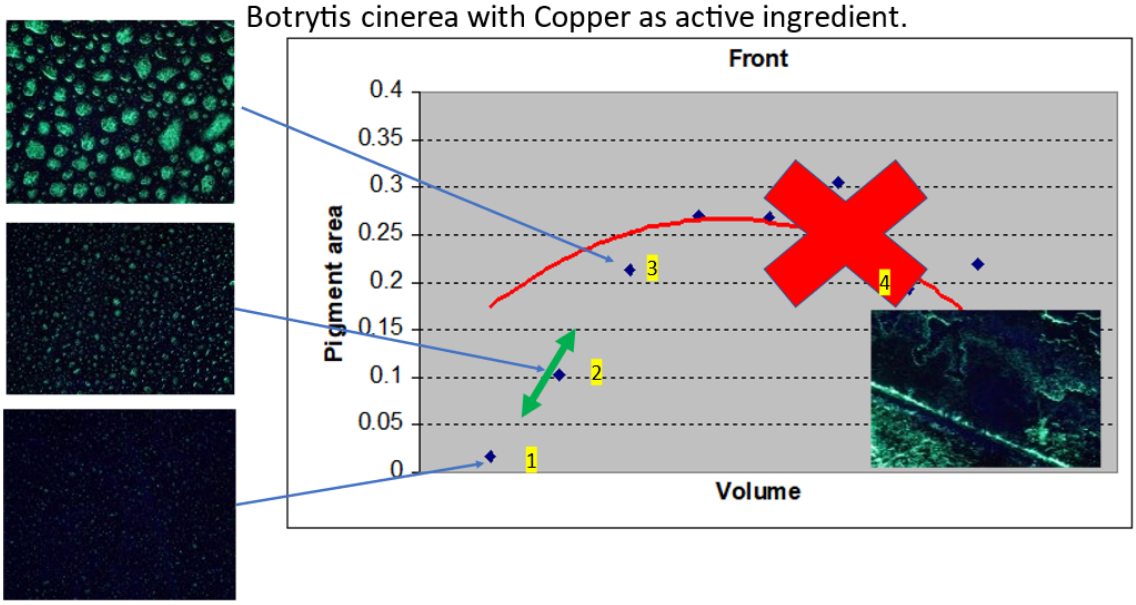
DEPOSITION AND BIOLOGICAL OUTCOME CORRELATIONS

Nobody will dispute the intuitive "fact" that better deposition efficiency of the formulation should lead to better biological outcomes – but how much is "enough" and what can be considered as "good spray efficiency"? On the contrary, one would state that "poor outcomes are expected when poor deposition efficiency is achieved."

When considering (arguably) the most stringent requirements for deposition/control correlations, one could reason that a **PREVENTATIVE** spray with a **CONTACT** product to prevent **FUNGAL** infections should be the biggest challenge.

A. During a PhD study by Jan Cor Brink at the University of Stellenbosch, Dr Brink concluded in 2012 on the subject of "Optimization of fungicide spray coverage on grapevine and the incidence of Botrytis cineria" the following:

Deposition Quantity (FPC%) & Quality (ICD%) vs Volume applied & control of Botrytis cinerea with Copper as active ingredient.



1. When depositing Copper at about 2% FPC levels, with excellent quality of distribution, the required 75% control was not achieved.

2. Upping the deposition of Copper to 5% – 15 % FPC levels by increasing the spray volume and maintaining the concentrate of the tank mix, the required 75% control benchmark was achieved. It varied in requirement between 5% – 15% FPC depending on the growth stage and the location in the plant.

3. Increasing the deposition of Copper to 21% FPC by further increasing the volume applied, (at the same tank concentrate) reached a point where high droplet density caused the Hydrogen forces in the water to accumulated the droplets, and reduced the **QUALITY** of the distribution – decreasing the control outcome.

4. Exceeding 25% FPC deposition levels initiated a complete breakdown of deposition **QUALITY**, initiating run-off and a simultaneous loss in deposition FPC%. This led to poor control outcomes.

OBSERVATION

Different natural surfaces have varying limitations as to the amount of water it can "carry & hold". The hydrogen forces in water play an important role in accumulating the droplets – especially if high droplet counts result in droplets touching one another. This will lead to accumulation and subsequent run off.

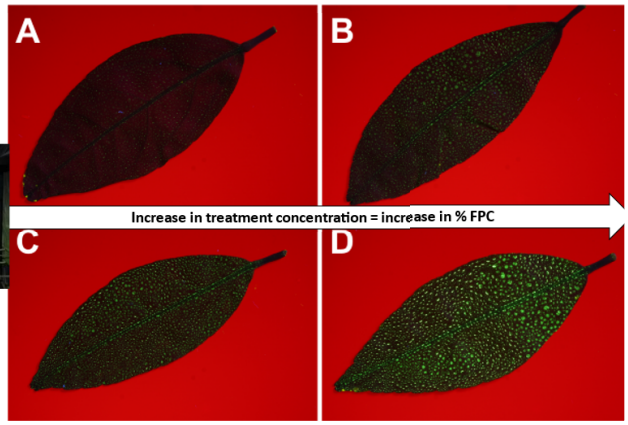
Water droplet retention is thus limited by the characteristics of the natural surface, limiting the amount of active ingredient/formulation that can be retained on the target surface area and ultimately the biological efficacy that can be achieved.

It is also to be noted that in general the reaction to poor outcomes of spray applications in the industry is mostly "rectified" by INCREASING the water volume sprayed per hectare. This could have just the opposite effect as would be required as shown from the above study.

B. Following along similar lines of thought, the CRI and the Stellenbosch University of Plant Pathology considered the outcomes of preventative control of Citrus Alternaria alternata pv *citri (Alternaria Brown Spot)* by keeping the volume sprayed constant, but increasing the tank concentrate. This should prevent the problem of excessive water droplet counts touching, hydrogen forces accumulating the droplets and run off.

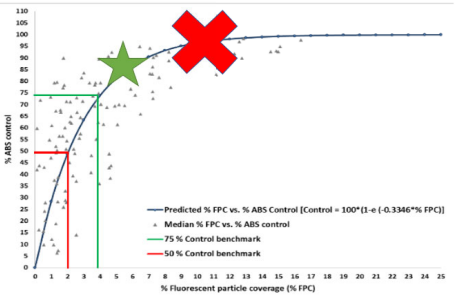
The outcome showed an increase in QUANTITY of deposition far beyond the levels achieved in the Vineyard study, whilst the QUALITY of the distribution on the surface was maintained.

Alternaria Brown Spot: Citrus



"Just Enough" Deposition Quantity (FPC%) and Biological Efficacy

CITRUS leaves spray-inoculated with Alternaria alternata pv citri (Alternaria Brown Spot pathogen)



The resultant deposition/control correlation pointed towards an "optimum" control of 95% expected at (Just Enough) 8% FPC deposition, provided that the QUALITY of the deposition is maintained.

It can also be observed the deposition levels exceeding 10% FPC would not contribute to better biological outcomes, and could thus be described as "excessive deposition".

OBSERVATION

It is possible to achieve much higher levels of deposition of the formulation by increasing the concentrate rather than increasing the spray volume above a certain level. This also correlates with the expected biological efficacy.

This is the key to satisfying the EU GREEN DEAL requirements without undue risk on the biological outcomes.

MEASURING SPRAY DEPOSITION EFFICIENCY – DROPSIGHT®

Patent #2022/02473

DROPSIGHT® technology, for measuring the spray deposition quantity, quality and uniformity of the miscible tracer representing the formulation, comprises of:

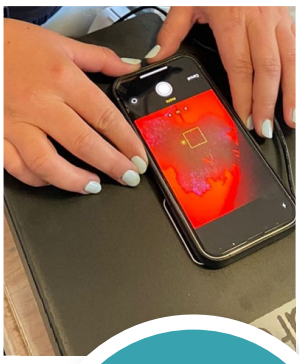
1. UVIEW miscible Tracer:

- Although completely safe, **UVIEW** is a not a registered food grade product, and each county of use should consider the correct legal requirements for proper use.
- **UVIEW** is not to be tank mixed with pesticides, but only used for small plot spraying trials.
- If sprayed onto edible foodstuffs, it is required to dispose thereof.
- A 2% tank mix is used to simulate a single concentrate (1x) spray application.

2. LEAFLAB

- The **LEAFLAB** is a portable UV photography laboratory comprising of:
- A lid with **UV LED's** and a UV Filtered lens opening through which photos can be taken of samples.
- A red fluorescent paper base covered with an opaque red plastic filter, defining the background which is recognized by the software for the photos.
- Sprayed leaf samples are placed one by one in the **LEAFLAB**, the lid closed, **UV LED'S** activated, ready for photography.

3. DROPSIGHT® Application



The **DROPSIGHT®** Application is accessed and downloaded via www.dropsight.ag and activated (6 months usage) in the Client Registration portal on the website by entering the unique serial number laser engraved on the **LEAFLAB** lid.

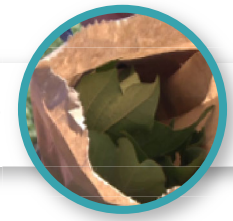
Usage can be extended via the same portal by either paying for it directly via the website, or purchasing vouchers from you closest **DROPSIGHT®** dealer.

Once activated, there is no limitation on the number of trials and samples evaluated – all original data is stored on the **DROPSIGHT®** cloud server for the user to access and download as and when required.

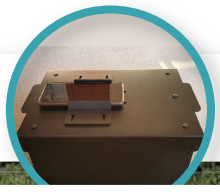
DROPSIGHT® TRIAL PROCESS

2% Tank Solution
= 1x Simulation

Harvest Samples



20 Leaves
x 3 Reps



DROPSIGHT® App processed data

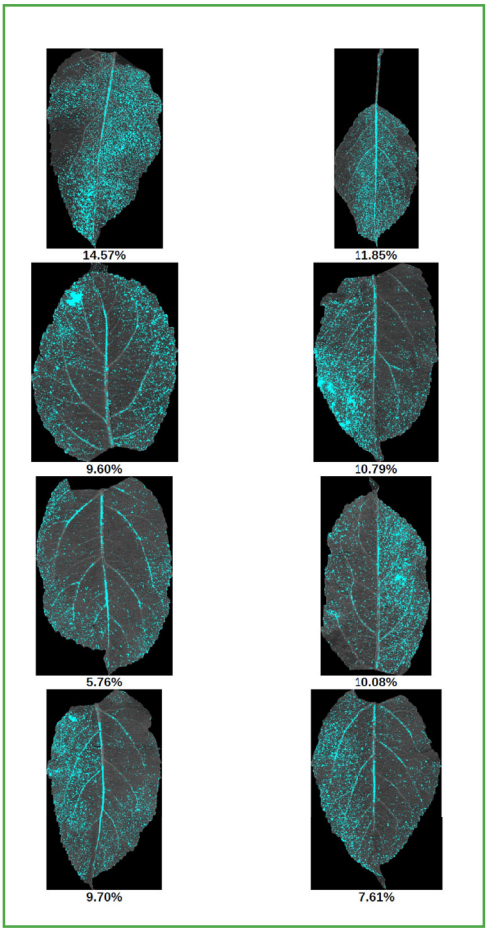
Smartphone photos

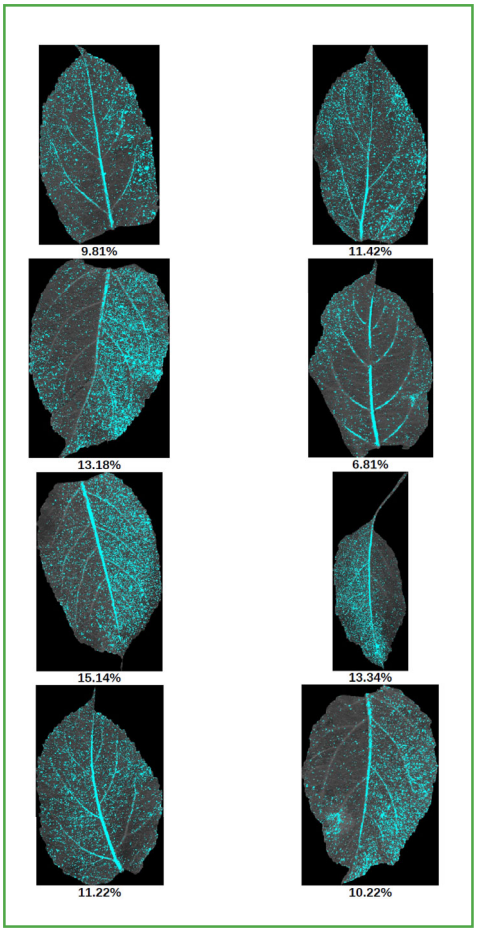
STEP 4

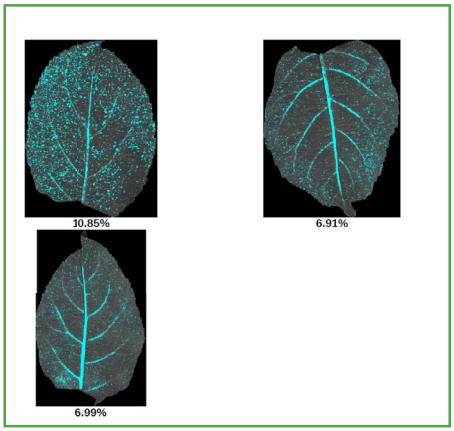
Process through **LEAFLAB** (Seperate upper & lower leaf batches)

The data can be downloaded in a standard PDF report, or in CSV format.

4. DROPSIGHT® PDF report format







Summary of results

Deposition Quantity	FPC%
Average	11.21
Standard Deviation	14.26
68% of values lies within	0 - 25.47
95% of values lies within	0 - 39.73
99.7% of values lies within	0 - 54.00

DROPSIGHT® OPERATIONAL BENEFITS

IMPROVING DEPOSITION ACHIEVED

- Benchmark status quo of deposition efficiency of your current sprayer set up.
- Cross reference with current commercial outcomes of your spray program.
- Identify possible shortcomings in sprayer set up & use of adjuvants.
- Improve sprayer set up and compare with benchmark.
- Take note of research deposition benchmarks – not yet a direct comparison.
- Make this data part of your spray application program data, comparing and improving your sprayer set up on a seasonal basis.

UPGRADE TO BETTER SPRAY TECHNOLOGY

- Evaluate any new technology against your set benchmarks.
- Evaluate any new suggestions in calibration and set up against your set benchmarks.
- Evaluate the impact of adjuvants & additives on deposition efficiency.

Measure, do not mess!

DROPSIGHT® VALUE PROPOSITION

The DROPSIGHT process is in-field, real time, giving both visual and quantitative report data to base decisions on improved spray deposition upon.

- Reduce the risk of poor biological control outcomes due to poor sprayer set up and deposition.
- Reduce the risk of unacceptable residue levels due to accumulation and run off resulting from too high volume and/or too large droplet spectrum used.
- Reduce the chemical losses due to run off resulting from excessive spray volumes.
- Reduce the risk of soil and ground water contamination due to excessive spray volumes.
- Optimize the use of chemical formulations preventing over- and under application, minimizing crop loss and potential resistance development.
- Optimize the use of adjuvants and additives to improve deposition efficiency.
- Optimize the design of sprayer performance.
- Risk management for contract spray applicators.

DROPSIGHT® USER BENEFICIARIES

- Chemical formulation development will benefit when deposition parameters become part of the researched requirements.
- Ultimate registration of formulations against minimum required deposition parameters will reduce the risk of failure due to poor deposition.
- All field trials of chemicals should refer to the deposition parameters required & achieved.
- All crop specialists and technical persons working in the field of chemical development and consultation will add valuable information to their technical portfolio when adding deposition requirements and the ability to measure it.
- Wholesale and Retail agents should include deposition assessments as part of their professional service and advise to customers.
- Consultants doing registration trials, servicing customers and/or insurance companies.
- All designers, developers, manufacturers, importers, and distributors of Spray Machinery.
- All commercial farmers should be able to do on farm assessments of their sprayer depositions throughout the season, adjusting and improving constantly on the outcomes.
- Spray contractors: Aerial & Ground rig
- Nozzle suppliers.

DROPSIGHT® technology is internationally available through more than 80 distributors operating in more than 30 countries, making the completion of the Responsible Pesticide Use Triangle possible for everybody involved in Agriculture.
(See Distributor listing on www.dropsight.ag)

The EU GREEN DEAL program, which was initiated in 2022, requires a 50% reduction in the use of pesticides by 2030 – only seven harvest seasons from now. DROPSIGHT® is the technology that will make this goal achievable, and at the same time mitigates the risk of poor biological control outcomes.

European Green Deal

Don't get left behind – the missing link to your spray calibration optimisation is available, cost effective and easy to use!

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