NEW TECHNOLOGY IN VINEYARD SPRAYING

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Introduction

Spray application is an important and costly problem facing growers and effective application requires attention to detail if off-target drift and public outcry is to be avoided.

The majority of growers use older, traditional design airblast sprayers fitted with hollow cone or air-shear nozzles that provide a large amount of air to penetrate the canopy and beyond, often resulting in a vast plume of spray drifting above the target row, particularly when a sparse canopy exists in early to mid season.

Current spray practice is often to use the same settings on an airblast sprayer in the vineyard from the first application through to the last, irrespective of changes in canopy volume or density. Changes should be made to air flow (speed, volume or direction), forward speed and application rate as the season progresses and the canopy develops. Growers frequently drive too fast and often pay too little attention to deposition on the leaves and grape clusters where disease or insects may occur.

The objective in pesticide application is to find the optimum combination of parameters for different stages of canopy development to improve deposition while reducing drift.

Weather plays a critical role in improving spray application. Wind velocity, relative humidity, and temperature all affect the characteristics of the spray plume. As wind speeds increase, spray droplets will drift further. Humidity and temperature determine how fast the spray will evaporate. A higher temperature means the droplets are more apt to dissipate and in some cases vaporize completely. At lower humidity, evaporation occurs much faster

Droplet size is important in determining the amount of drift in conjunction with the wind, temperature and relative humidity. The size of a droplet strongly influences its trajectory after being emitted from a hydraulic nozzle at a speed of 45-67 mph. Training the operator to recognize conditions which lead to excessive drift such as high winds, fine spray, inversion layers etc. is so important.

Improving existing application techniques to improve deposition and reduce drift

1. *Weather monitoring equipment.*

All growers should purchase and use good quality instruments for measuring wind speed, temperature and humidity. Small, hand held anemometers cost around $100 and provide fairly accurate information. Spraying with no wind present is dangerous due to potential problems with vapourisation and inversion layer conditions, similarly, spraying when wind conditions are too high is equally dangerous. An inexpensive wind speed monitor is a get-out-of-jail card, court judges in drift cases recognize professional applicators who know local weather conditions rather than rely on an airport weather station ten miles away!

2. *The Sprayer and the operator*

One of the simplest ways to help improve deposition is to maintain and calibrate the sprayer. A well trained operator will notice a spray plume drifting away as wind speed increases or changes direction. Replacing worn nozzles when they exceed the manufacturers flow rate by 10% and matching the correct nozzle to the type of application is a fairly inexpensive practice to improve effectiveness. In New York State the author is conducting 11/2 day operator training courses to improve the standard of application of pesticides to grapevines.

3. *Nozzle orientation*

Orientation of the nozzles affects the spray pattern being emitted from an air blast sprayer. Where the air flows the droplets will surely follow. At Cornell University an Italian vertical patternator, a MIBO, has been used for the past four years to evaluate 60 sprayers approximately. Results from patternator trials, figures 1 and 2, show not only the great variability in spray pattern produced according to nozzle orientation but also the lack of symmetry between each side of the sprayer. On a Berthoud S600EX sprayer, as an example, nozzles set in the "typical growers" pattern, Figure 1, pointing radially outwards, resulting in a large quantity of spray (about 33%) being blown above the target row. The best spray pattern for the grape zone, Figure 2, occurred when the right hand side nozzles were pointing horizontally and the top two nozzles were 20^{o} below horizontal on the right side, to counteract the upward movement of the air from the fan. Best results occurred with the left side nozzles pointing 45^{o} upwards to counteract the downward direction of the air from the fan. The results show the importance of correct nozzle orientation if pesticides are to be applied effectively onto the target.

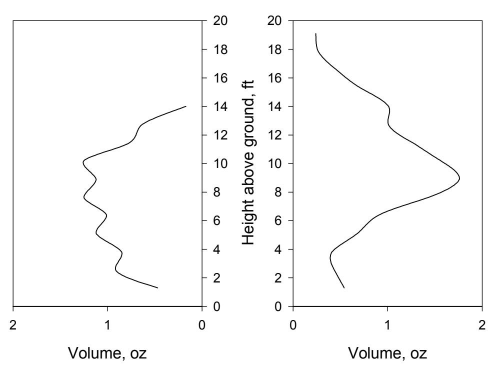

Figure 1. Original nozzle setting

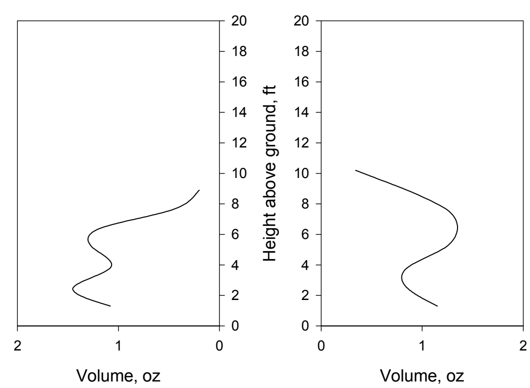

Figure 2. Improved nozzle setting

NOTE: Results shown are for a Berthoud S600EX sprayer, individual sprayer models will vary.

At Cornell University we have developed 2 simple vertical patternators which growers can build on their own farms to evaluate their spray plume and nozzle orientation in relation to the canopy. They are made from inexpensive materials and compare favourably to the more expensive Italian patternator. Plans are available on the author's web page.

4 *.Nozzle selection*
Droplets under 150 microns generally pose the greatest drift hazard; droplets less than 50 microns have insufficient momentum for impact as they remain suspended in the air indefinitely or until they evapourate. Deposition efficiencies mat be as low as 55% of the applied spray from an airblast sprayer, suggesting that 45% of pesticide hits the ground contaminating the soil and goes up into the air. Trials at Cornell University, using Albuz, Lechler and TeeJet air induction nozzles, can reduce drift by at least 50-65 percent. They work well with systemic products and are also ideal for use in weed sprayers.

5. *Regulating air speed and volume.*
Frequently the greatest culprit is excessive airflow for the available canopy. There are various ways to adjust airflow.

Regulating the PTO speed of the tractor is an inexpensive way to improve deposition and reduce drift. Where the air goes, the droplets will surely follow. Early – mid season sprays are frequently applied at full fan speed, resulting in a mighty plume of pesticide going towards a small leaf target on a small vine or up into the air above the vineyard. Is it necessary to have the fan rotating at all or even rotating at very slow speed? Do we really need to use an airblast sprayer creating an airspeed of up to 120-200 miles per hour when our leaf target is only a few inches long in early season? In trials at Cornell University**,** with an airshear type sprayer drift was detected up to 80 feet from the target row. When the tractor PTO speed was reduced by just 25%, drift was reduced by 75% .

Using a hydraulic motor to drive the sprayer fan will allow the operator to regulate wind velocity. A hydraulic control valve can be fitted in the tractor cab to allow the operator to infinitely vary the fan input speed from 0 rpm up to 540 rpm. The operator can adjust air speed according to canopy growth and if near neighbouring properties, drift-sensitive crops, roads or water courses. Ensure the tractor has a high enough oil flow (gallons/minute) to drive the hydraulic motor at speed.

Restricting air intake and air flow via a simple plywood “doughnut” that can be constructed using a jig saw and then attached to the sprayer air intake using bolts. A safety grill must be fitted to prevent fingers from entering the fan. For early season, a 1/2 diameter air intake doughnut can be used, allowing just enough air to penetrate just the target row. A 2/3rd air intake hole can be used for early/mid-season to allow more air to flow. Finally in a full canopy, no doughnut is required. Results of trials indicate excellent improvements in deposition and drift reduction from a simple yet effective device.

In order to accommodate varying crop canopies, e.g as the season progresses, different trellis systems etc., a number of modern sprayers are fitted with adjustable pitch blades to provide a variable airflow. Operators can manually adjust blade pitch either by turning a handle or altering individual blades. Growers should assess air volume requirements by observing spray penetration into the canopy and the amount of spray going up and over or through the canopy.

The use of grape towers and end plates direct the air towards the canopy in a horizontal direction, improving deposition considerably. In some cases the horizontal airflow can be adjusted via internal deflectors to direct the air e.g. towards the fruiting zone.

Current research at Cornell University is to devise methods of reducing airflow on the move using an adjustable louvre and electric actuators (see below)

6. *Directed deposition sprayers*

Modern sprayer designs such as directed deposition sprayers help improve deposition by spraying inwards to the canopy, often allowing the operator to vary the position of the air outlets towards the canopy or target zone. Multirow sprayers can improve deposition by upto 30% due to the converging airflow resulting from the airstream being targeted and meeting within the middle of the canopy. Many modern sprayers use low volume fans running at higher speeds to generate a localized airflow. Ease of maintenance, nozzle selection and the incorporation of modern ideas such as powder induction baskets, hand and tank washing systems result in growing popularity. Electrostatics may help improve deposition.

7. Logistics

Timeliness is all important for effective spraying, growers should review the logistics of their spraying operation and ensure rapid filling, reduced travel to refill and clear instructions per vineyard block. Good machinery and operator management, as always, will improve efficiency.

8. Precision spraying

The challenge for the fruit grower in the 21st century is to apply pesticides precisely to the target areas. Current research by the Cornell University Spray Team is on developing new canopy sprayers for vineyards to increase deposition within the canopy using adjustable air louvers and sensors. Trials have been conducted to evaluate their design throughout the growing seasons of 2008 and 2009. Results from field trials have shown improvements of up to 30% increase in deposition and a 75% reduction in drift using louvres and reductions in pesticide use of up to 40% have been recorded in using infra-red sensors in early season applications to vineyards.