Spot-on spraying for greenhouses

Spraying to control pest and disease in a wind-less greenhouse environment is becoming an exacting science. Dr TERRY MABBETT outlines the characteristics of wind-assisted spray machines available on the market.
Greenhouse grown crops are intensively grown and of high value. Reliance on pesticide application has progressively decreased with the emergence and establishment of biological control and integrated pest management programs as front line defense.

Natural enemies such as predators, parasitoids or parasites such as Encarsia, Phytoseiulus, Amblyseius and Chrysoperla, and released into the greenhouse environment as biocontrol agents, are density dependent control factors designed to follow, manage and eventually overwhelm an increasing pest population. Situations will always arise where pest populations outstrip these natural enemies and therefore require instant control, something natural enemies are not designed to achieve.

The controlled greenhouse environment provides plants with most favorable growing conditions. The same conditions favor rapid spread and development of arthropod pests and diseases within high value crops like flower blooms and premium salad vegetables all with low economic damage thresholds. Growers cannot afford not to spray if the situation demands, but by the same token it must be discrete and to exacting requirements, whether for cut flowers, fruit, vegetables or ornamentals.

Spraying to control arthropod pests and fungal diseases is restricted and constrained by a number of factors related to the nature of the controlled greenhouse environment and crop safety. Spraying within the confines of a wind-less environment requires air-assistance to project and impact droplets onto target crop surfaces. Air turbulence ruffles the foliage allowing good canopy penetration and under-leaf cover of small spray droplets.

These application requirements are crucial for protection of dense-canopied flower crops like chrysanthemums that are susceptible to the feeding activities of many different sucking pests including aphids, thrips and whiteflies mostly, often on the under-leaf surface. Air assistance should be strong enough to target the spray droplets but sufficiently controlled to maintain integrity of delicate blooms like gerbera. Air movement created by spraying should not be so strong as to disrupt any biological control programmes (predator and parasitoid/parasite release) within the greenhouse.

Machines employed should ideally apply waterless sprays or the absolute minimum of water and be sufficiently small and discrete for carrying through closely paced, fast-growing and densely planted crops without causing physical damage to plants.

A range of portable sprayers are widely used on outdoor crops, and some previously in greenhouses, but virtually all lack complete compatibility with the requirements of modern greenhouse growing systems.

**Lever operated knapsack sprayers**

Apart from being too bulky to carry back-mounted along and between rows of tall, dense crops of tomatoes and cucumbers, these high volume hydraulic sprayers suffer from two more specific disadvantages. The first relates to lack of canopy penetration and under-leaf cover by droplets, and the second to high humidity resulting from the high volumes of liquid water that have to be used.

Large spray droplets generated by these hydraulic sprayers lack the momentum to fully penetrate dense foliar canopies. Undersides of leaves are not adequately covered. This has serious control implications for protection crops like chrysanthemums and tomatoes, subject to the feeding activities of sucking pests including aphids, thrips and whiteflies and invariably on the lower leaf surface.

Relatively large spray droplets and high volumes of spray liquid typically delivered by lever operated knapsack sprayers can ruin cut flower quality by leaving stains over the blooms and foliage. In the past growers using lever-operated knapsack sprayers were advised to pick any open blooms prior to spraying.

Lever-operated knapsack sprayers use high volumes of water equivalent to around 1,000 litres/hectare and produce 'run-off' coverage, whereby leaf surfaces are completely wetted with spray with the potential for generating ultra-high humidity. High humidity is an inherent feature of most greenhouses. It produces fast growing, soft and succulent crops and is generally beneficial for the establishment and activity of predators and parasites. And essential for the success of myco-insecticide biocontrol products such as Verticillium lecanii. An entomopathogenic fungus deployed to destroy aphids, whiteflies and other insect pests.

That said, surface wetness and high humidity are a boon to many plant pathogens and especially the Botrytis (grey mould) fungi. High volume spraying in the greenhouse, particularly early in the morning and late afternoon when humidity is naturally high, can spark epiphytotic of Botrytis. The fungal has the capacity to destroy marketability of crops literally overnight and attacks virtually all mainstream greenhouse crops with carnations, chrysanthemums, roses, gerberas, lilies, tulips, freesias, tomatoes, cucumbers and lettuce all susceptible.

**Low volume mistblowers**

Shoulder-mounted mistblowers satisfy most of the requirements of greenhouse spraying but at the same time introduce several additional negative factors. These reduced volume machines use much less water and produce generally smaller droplets with high momentum that enables penetration right into the canopy with good under-leaf cover. On the downside, they are even more bulky and obstructive than lever-operated knapsack sprayers and the air blast generated is just too powerful for use on delicate greenhouse crops, especially cut flower crops and ornamentals. Furthermore, they are powered by two-stroke petrol engines, exhaust fumes from which are completely incompatible with the greenhouse environment from both crop integrity and biological control agent points of view.

**Spinning disc sprayers**

At first sight hand-held battery operated spinning disc sprayers would appear to offer the answer. These are ULV (ultra low volume) machines using very low volumes (less
than 10 litres/hectare of spray and producing uniformly sized small droplets to provide controlled dosage application (CDI). However, the one big drawback is that they were designed for spraying outdoor crops. The droplets are generated by rotary atomisation from spray liquid spread over the surface of a toothed disc spinning at ultra high speed. Liquid moves to the edge of the disc and forms ligaments of liquid at the points of the teeth.

From here, uniformly sized droplets are "chopped off" in rapid succession by the centrifugal forces of the spinning disc. The only momentum possessed by the droplets is that imparted by the centrifugal force as the droplet is formed. In the field this does not matter because the operator always sprays with light wind speed allowing droplets to be drifted into the crop canopy. Clearly, there are no wind movements in greenhouses so the system cannot work.

**The answer - atomisers or fan-assisted ULV sprayers**

The exacting requirements of greenhouse spraying clearly rule out virtually all traditional mainstream sprayers, but the solution has been provided by a unique range of small, light-weight, hand-held sprayers that combine the best of the rest. Droplets are generated by rotary atomisation, but behind the disc is a powerful fan producing an air-stream to deliver the droplets to target. The air-stream is powerful enough to deliver the spray while not strong as to physically damage the crop. Droplets are small with spray volumes and dosages correspondingly low.

They are ideally designed and equipped to use water-less sprays at ultra low volumes in which the carrier liquid for the pesticide is oil-based. However, they can also be used to spray very low volumes of water-based sprays. This minimises or even eliminates any potential problems with high humidity and research has shown oil-based carrier liquids actually improve tenacity of the spray deposition on the foliage. Two-stroke petrol engine models do exist for use on outdoor crops including small orchard trees. The models designed for greenhouse spraying are electrically powered by mains electricity or battery.

The machines have been developed and marketed by Micron Sprayers Ltd, a United Kingdom (UK) based organisation with strong Australian roots through its sister company Environmist Pty Ltd in South Australia. The Micron Turbair range for greenhouses comprises the mains-powered Turbair Electrafan 110/240 and the 12v DC battery-operated Turbair Electrafan 12.

Specifications of the Electrafan 12 clearly indicate the small size of droplets produced and the correspondingly ultra low volumes of liquid used. The disc spins at 7,000 to 8,300 rpm. Spray liquid flows onto the disc at 30-110ml/minute to produce droplets of 60-70um vmd [volume median diameter] and projected up to 5m onto the target under influence of the fan.

A not overpowering air blast created by the fan delivers a droplet laden air-stream into the foliage. The leading edge of the air stream removes the boundary layer of still air around the leaves and allowing those in the outer layers to flip back and expose their undersides to spray. In
addition, this ruffling of the outer canopy layer opens up the canopy shell allowing droplets to move right inside.

These events have several positive implications for pest and disease control. Under-leaf coverage is important because aphids invariably feed from the lower leaf surface and form colonies there. Jassids (leafhoppers and planthoppers) feed from raised leaf veins on the under-leaf surface. Adult whiteflies lay eggs on the under-leaf surface where the sedentary scale-like whitefly larvae reside and feed. Leaf and fruit eating lepidopterous larvae invariably rest up on the lower surface of leaves and deep inside the canopy heat of the day.

Many foliar fungal infections begin on the under-leaf surface which provides an easier point of entry (thinner cuticle and stomata) and generally provides more conducive conditions (free water and high humidity) for spore germination. The interior of the canopy is perpetually moist and humid providing ideal conditions for fast development and spread of diseases.

The Dutch experience
The Netherlands is one of the world’s ‘hottest spots’ for innovation in all aspects of greenhouse crop production and was one of the first to take up this technology for instant control of pest and disease ‘hot spots’.

One nursery using the equipment is Van der Valk-Den Drijver at Honserlensdijk where owner, Mr A. Van der Valk, has employed Micron’s battery-powered 12V Turbair Electrafan sprayer for over 10 years.

‘Use of the Electrafan 12 is completely compatible with our strategy to use beneficial insects as the mainstay of the crop protection program. Agrochemicals are only applied when absolutely necessary and in the smallest effective quantities,’ said Mr Van der Valk.

‘Hot spots of fungal infection and pest infestation requiring prompt action do occur and the quicker we act the easier it is to eliminate the problem without disturbing the delicate balance between beneficial insects and their insect pest hosts and prey,” he added.

The lightweight and portability of the battery-operated version he uses is, he says, ideal for quick spot spraying of pest and disease hot spots around the greenhouse. The air assistance generated by the Electrafan 12 enables the droplets to penetrate into the crop canopy to give good control at dose rates 50% lower than normal.

Other growers have gone one stage further and adapted the Electrafan equipment in a novel mechanised robotic sprayer. Bunnik Plants at Bleiswijk uses no less than 12 Electrafan 12s simultaneously with just one operator made possible through a custom-made robotic spray gantry, dubbed the ‘Flying Doctor’.

It was developed for the company’s highly automated glasshouse.

The Electrafan 12s derive their power from a large battery. The gantry is a remote-controlled frame and travels up and down the glasshouse above the crop.

“When the greenhouse was built we invested a large part of our input in the use of environment friendly pest control systems based on predator and parasite release”, says managing director Frans Bunnik.

‘Before the spray robot was designed and built, we applied 1,000–1,500 litres of water/ha, but the Flying Doctor does a better job with just 75–100 litres/ha and up to 70% less pesticide.

‘This (The Flying Doctor) offers big environmental safeguards as well as a significant saving on pesticide and these gains are possible through improved penetration into the canopy and superior coverage provided by the narrower droplet size spectrum and air assistance. Even difficult-to-control insect pests such as thrips succumb to the Flying Doctor.’

‘Operation via remote control makes it ideal for spot application that safeguards our beneficial insects, as well as making life a lot easier for our crop protection specialist,” comments Frans Bunnik.

Control using ultra dosage of pesticide is an economic and safety bonus for any crop situation and especially so for greenhouse crops. Those charged with crop harvesting and picking will always be in close contact with both plants and harvested crops. And whether these are cut flowers or salad vegetables, further close contact and handling will occur during packing and marketing. Many crops like tomato are harvested almost on a daily basis, which means any pesticide used must possess the absolute minimum safe harvest interval.

About the author
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