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Electrostatic spray heads convert knapsack mistblowers to electrostatic operation

ELECTROSTATIC technology significantly improves spray deposition on the top and bottom surfaces of leaves, reduces drift and run-off, provides a means of reducing the amount of pesticide/diluent and, thereby, increases the efficacy of pesticide application.

Spectrum electrostatic sprayers from Southwest Electrostatic Sprayers, Inc. of Houston, Texas have been successfully used for several years in agricultural markets in the USA, on crops such as citrus, stone-fruit, avocado and tropical fruit and in orchards and vineyards.

Spectrum models range from 30-600 gallon pto-driven trailed sprayers and three-point (tractor mounted) sprayers and skid-mounted sprayers with integral power source. In addition to agricultural applications, several of the models are designed for multi-purpose use in landscape management and greenhouse/nursery and dairy/live-stock operations.

Conversion spray head
The most recent development from Southwest Electrostatic Sprayers is the Spectrum 3010 Electrostatic Spray Head which converts most motorised knapsack mistblowers to electrostatic operation. It weighs less than a pound (0.4 kg), requires no external battery power source and is simple to install.

The spray head fits over the end of the knapsack air duct, the inside of the head being tapered to provide a secure fit on different makes/models of knapsack. Inside the head, on one interior wall, is the patented OGee airshear nozzle, fabricated from non-conductive plastic. Mounted on the opposite interior wall is the conductive electrode.

Outside the head, the electrostatic power supply (RC filter and rectifier circuit) is connected by a single wire to the knapsack magneto at the spark plug. A second wire, connected to the chassis of the knapsack, provides the earth.

Current is supplied to the electrode when the engine is started and results in the creation of a negative electrostatic field within the head. With the OGee nozzle and electrode placed on opposite walls — and within the airstream — liquids released from the nozzle are simultaneously atomised and electrostatically charged.

Application performance upgraded
Deposition studies have shown that knapsacks, equipped with the 3010, deliver 50% more droplets to a target surface than are delivered by standard spray heads.

Beyond the potential of the 3010 for improving knapsack efficiency in agricultural/horticultural applications, evaluations are currently underway to assess the potential benefits of electrostatic knapsack application to the public health area. Investigations are being directed towards determining if the increased deposition associated with this technique will extend the residual activity of mosquito adulticides commonly used in dengue and malaria control, or if the increased deposition will allow a smaller amount of active ingredient to be used.

The key to this device — and to all Spectrum sprayers — is that air-assist, airshear and electrostatic technologies are used in combination. For the 3010, the air-assisted portion, a high velocity airstream, is provided by the knapsack mistblower.

The 3010 components then, physically and electrically, alter the spray to improve its movement and deposition. To achieve this, liquids are atomised into smaller, more uniform droplets, 50-60 microns in size, that carry a strong positive electrostatic charge.

Numerous studies have been conducted to compare Spectrum electrostatic sprayers with conventional hydraulic equipment. In all these studies, air-assisted/electrostatically charged
sprays resulted in more efficient delivery of spray to the target. Examples of the findings include: chemical application costs in citrus pest management reduced by $70-78/acre (33%); pesticide deposition in orchards increased by 46%; foliar uptake of nutrients in pecans increased by 31%; and dermal/respiratory exposure of workers to azinphos-methyl reduced by 82%.

Importance of droplet size
Electrostatics apart, the range and size alone of droplets in any given spray has tremendous influence on coverage, volume of spray used, retention, fallout and drift. For treating foliage, the optimum range is generally considered to be between 40 and 100 microns (μm). Droplets in this range cover more surface area, require lower volumes, are more readily retained and less susceptible to fallout and runoff than those >100μm; they are also less susceptible to drift than those <40μm.

The surface area of any liquid is enormously increased when broken into small droplets. Therefore, the volume needed to cover plant surfaces decreases proportionally with droplet size. Table 1 provides a wide range of droplet sizes/corresponding volumes with which 50-60 μm droplets can be compared.

Studies have also shown that larger droplets are not well retained due to their high kinetic energy. When droplets >150μm strike certain leaf surfaces, they become flattened, but their kinetic energy is such that they retract and bounce away. Very large droplets, >200μm, have so much energy that they shatter on impact. Small droplets are better retained as they lack the kinetic energy to overcome the surface energy and viscous changes that occur on impact and cannot bounce away.

<table>
<thead>
<tr>
<th>Droplet diameter (μm)</th>
<th>Fall time (3m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>28.10 hr</td>
</tr>
<tr>
<td>10</td>
<td>16.90 min</td>
</tr>
<tr>
<td>20</td>
<td>4.20 min</td>
</tr>
<tr>
<td>50</td>
<td>4.050 sec</td>
</tr>
<tr>
<td>100</td>
<td>10.90 sec</td>
</tr>
<tr>
<td>200</td>
<td>4.20 sec</td>
</tr>
<tr>
<td>500</td>
<td>1.65 sec</td>
</tr>
</tbody>
</table>

The weight of individual droplets and the effect of gravity on them increases proportionally with droplet size. Table 2 reflects the time to fall from a height of 3 metres in still conditions of a wide size range of droplets. Without electrostatics, Table 2 can also be interpreted reversely for drift. Here the risk of drift increases inversely with droplet size and proportionally with wind speed.

Uncharged/charged molecule differences
Uncharged sprays are made up of molecules in their normal, neutral electrical state, i.e. the atoms have equal numbers of protons (+) and electrons (−). A charged spray — or any object — has either had electrons added to or subtracted from its atoms. The Spectrum 3010 Spray Head gives knapsack sprays a "positive" charge by extracting electrons from them as they pass through.

Electrical force influence on spray movement
Where uncharged small droplets are more susceptible to off-site drift, charged droplets are not. When sprays are uncharged, neither the droplets nor the target surfaces have any influence on each other. The droplets are controlled by forces generated by the application equipment (pressure, air) and by the external forces of gravity and air drag.

Electrostatically charged droplets are, obviously, also influenced by these mechanical forces; however, since they reach the vicinity of the target, electrostatic forces take over to a very large degree. To compare influence, the electrostatic force on small charged droplets is 40X that of gravity.

The wrap-around effect, for which electrostatic sprayers are known, visibly shows that the attractive force between charged droplets and targets overrides gravity and inertia by pulling droplets out of their paths — up, down, sideways — to the closest surface.

The most notable difference is the increased deposition on under/back sides of leaves and in dense vegetation. It is widely recognized that some of the largest crop losses and vector control problems — caused by such insects as whiteflies, boll worms, mosquitoes etc — are due in large part to inadequate target coverage, particularly on the undersides of leaves.
over the electrode inside the head, fig. 1.

The primary substance, which carries the charge in sprays, is water because of its electrical conductivity, irrespective of whether or not the active ingredient is conductive. Electrostatic charging has no effect on the chemical makeup of the active ingredients.

Applications

Charged sprays are attracted to any targeted, conductive and earthed objects such as plants, trees, animals and certain types of building materials.

Thus, when spraying is taking place, as the collection of positively charged droplets approaches a target, it pulls the negative electrical particles, electrons, that are inside the target, up from the ground to the surface. As a result, the target surface becomes negatively charged, fig. 2. In turn, the negatively charged surface pulls the mobile, positively charged droplets to it.

Charged sprays, unlike uncharged sprays, resist coalescing into larger droplets both in transit and deposition. As each charged droplet is deposited on a surface, electrical charges balance out at that site, making it no longer attractive to other charged droplets. The droplets following are, therefore, pulled instead to the rest of the surfaces which remain attractive.

By changing the way pesticides are applied, the Spectrum 3010 offers farmers, horticulturalists and vector control professionals, who rely on knapsack sprayers, a more effective, economical way to improve control and reduce the chemical use and environmental damage caused by drift, run-off and fallout.

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Unpublished studies


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