

Influence of Electrostatic Spray on Plant Canopy: Theoretical and Engg. Practices

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ABSTRACT: Electrostatic pesticide spraying is the most useful method in current scenario to prevent the crops from various infections such as insecticides, fungicides and herbicides. In earlier days classical methods for pesticide spraying were used but the problem arising was complete coverage of pesticide, soil pollution and wastage of pesticides. The various research work was carried out to solve the problem and it has been observed that electrostatic spraying method plays important role to cover up the various areas of failure. This method involves use of air assisted electrostatic spraying with nickel electrode at the tip of nozzle having circular shape and high voltage can be applied. Due to which the droplets gets charged in atomizing area. This method is effective for uniform distribution of pesticides over the crops and this will result into reduction in cost with saving in pesticides and reduction in environmental pollution.

KEYWORDS: Electrostatic spraying, Nickel Electrode, Uniform Distribution.

I. INTRODUCTION

The term electrostatic spray finishing refers to a spray finishing process in which electrical charges and electric fields are used to attract atomized particles to the target. In the most common types of electrostatic systems, electrical charges are applied to the material (pesticide or any other liquid) and the target is grounded, creating an electric field. The charged particles of material are drawn by the electric field to the surface of the grounded target because of the attraction of opposing electrical charges. Other, less common types of electrostatic systems apply an electrical charge to the target and ground the material, or apply opposite electrical charges to the material and the target. Electrostatic spray charging improves the transfer efficiency of spray finishing equipment. The Transfer efficiency improvements occur because the electrostatic forces help to overcome other forces, such as momentum and air flow, that can cause the atomized materials to miss the intended target. Electrostatic methods save pesticide material, time and labor. More of the material is attracted and adheres to the target, and less material is lost in the spray booth and the surrounding environment.

To understand electrostatic spray charging, it must first be able to identify the types of charged Particles that make up matter and explain how charged particles impact one another.

1.1 Dynamics among Charged Particles

All matter has an electrical charge. Matter is made up of three types of electrically charged particles:

1. Negatively charged particles have excess electrons.
2. Positively charged particles have excess protons.
3. Neutral particles have a balanced number of electrons and protons.

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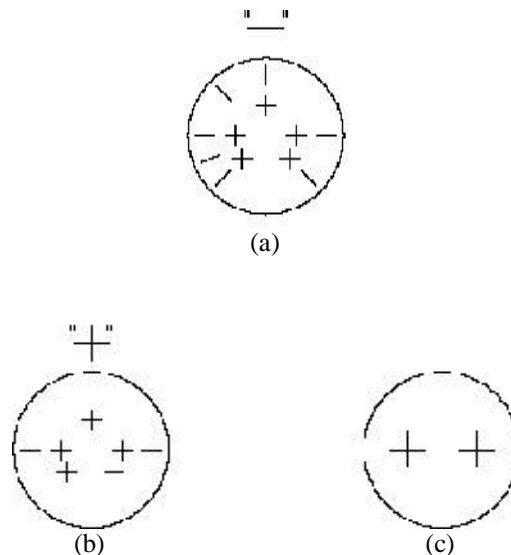
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Particles and objects with like charges repel each other, whereas particles with unlike charges attract each other. A single, isolated particle that is either negatively or positively charged will attract neutral particles. Charged particles are also attracted to the closest grounded surface.

The three types of electrically charged particles are illustrated in Figure

Negatively charged particle



II. RELATED WORK

Equipments and Methodology.

1. Defining the problems arising in current classical methods of pesticide spraying.
2. Suggesting new method for solving the problems.
3. Use of modified techniques in the method such as making of fine droplets with the help of compressor.
4. Use of various electrodes at the tip of nozzle.
5. Recommendation for improvement.
6. Electrostatic Charging Device.

The principle of Electrostatic charging device is illustrated in the above fig. The air and liquid enter separately into the nozzle. The air moves at a high speed through the nozzle with the help of compressor and disintegrates liquid into fine droplets. The droplets are charged by induction in the nozzle. High speed air flow through annular area assures that the droplets are swept past the electrode and propelled outward from the orifice of the nozzle.

Since the distance between the nozzle and the plant object to be sprayed is relatively wide, a high voltage must be applied to get enough induction charge. However if the spacing between the nozzle and the induction electrode is very small, the applied voltage could be much lowered, thus the concept of "embedded electrode electrostatic – induction nozzle" was developed. By Law and co-workers.

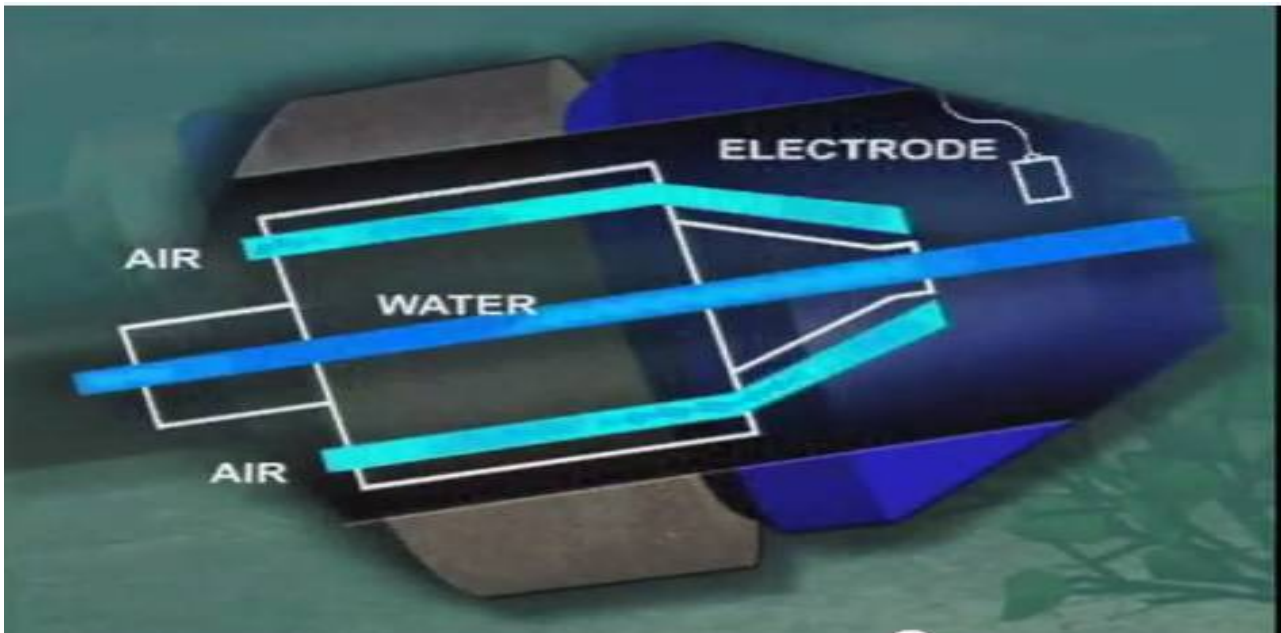
In some cases double acicular stainless steel electrode were mounted on both sides around the atomizing area for each nozzle and high voltage wires pass through the fixture and connect with stainless steel electrodes.

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(d)

Electrostatic spray nozzle creates the perfect spray drop. Optimal size and concentration coupled with a high electrical charge provide better spray coverage. The droplets are electrostatically attracted to plants which are essentially grounded. The science behind electrostatic spraying boils down to two basic principles of charged particles. Like charges cause the spray to split into even finer particles that repel from one another, pushing the spray deep into the plant canopy. The opposite charges in the plant attract the particles to it, drawing the spray into the plant canopy. The surface charges eventually equal out when the plant is fully covered in spray. This is how electrostatic spraying creates an even coating on all plant surfaces. ESS offers products with air-assisted, electrostatic sprayers to serve the agricultural, sanitization and industrial markets. The sprayers can effectively apply most common chemicals, pesticides, disinfectants and additives; providing us with a better coverage than a conventional sprayer.



(e)

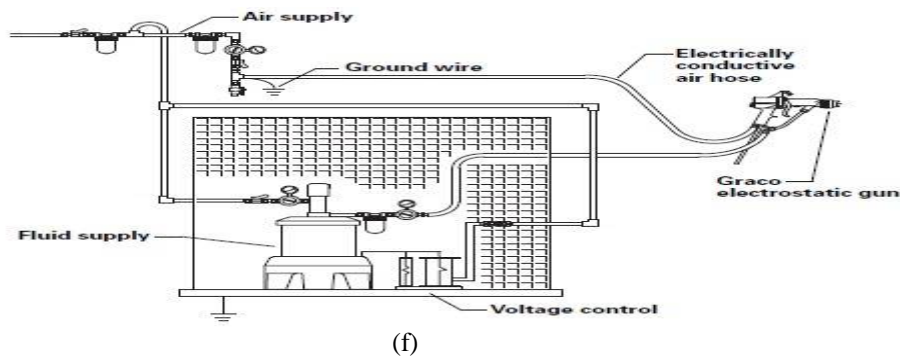
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The air-assisted electrostatic sprayers produce droplets 900 times smaller than those produced by conventional or hydraulic sprayers. These tiny droplets are given an electrical charge and they are carried deep into the plant canopy in a turbulent air-stream to coat all of the plant surfaces. The “wrap around” effect causes the spray to cling to the surface rather than being blown past the target, drifting away or falling to the ground. High-voltage electrode mounted on the nozzle produces high voltage which makes droplets charged. In order to ensure the formation of electric field, the high-voltage generator should be supplied with limited voltage and steady current. The highest voltage can be set by a regulating knob. Under steady power supply, stabilized current will decide current density of electric field. Voltage amplitude can be adjusted according to conditions of electric field. In this manner, output current keeps steady and charging equipment can work normally under wider variation range of electric field.



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The nonlinear DC high-voltage power supply technique was introduced in the high-voltage power supply equipment, i.e. the typical DC high-voltage switch power supply technique in DC-DC mode. . The MOSFET, IGBT, quasi-resonant frequency conversion technique (the frequency of power supply can be 2500Hz) and the silicon voltage multiplier technique were introduced. Compared with the linear power supply, it has outstanding characteristics of high efficiency, small volume, low weight, fast reaction, low power storage and short period of designing and manufacturing.

III. EXPERIMENTAL SET-UP

The experimental setup consist of Air compressor for atomization of droplets, an electric motor, a Nano Drop technology Nozzle, Nickel electrode embedded in nozzle and High voltage generator.



(g)

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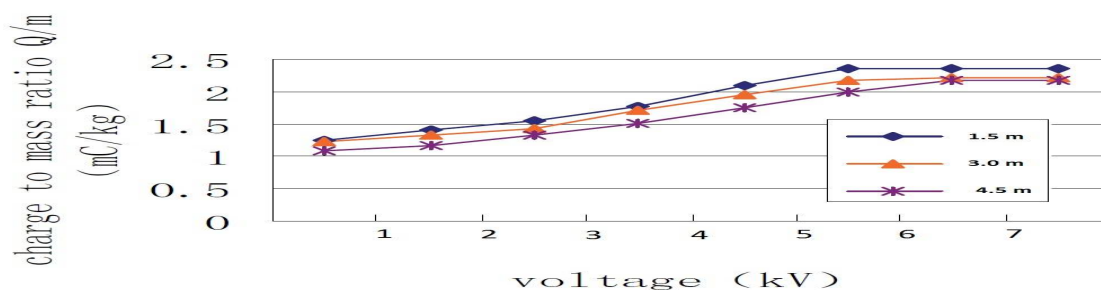
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In the compressor the pressure developed is up to 12 bar. The pesticide is taken from pesticide tank with the help of electric motor of 0.5 HP power and atomization of pesticide particles takes place with the help of nozzle and compressor. Nozzle is made up of Nylon which is of NDT (Nano Drop Technology) type. The Nickel electrode is fixed in nozzle. The amount of Pesticide can be control by using valve.

The current is applied on electrode by using high voltage generator and hence ionization of atomized particles takes place. These ionized particles are sprayed on the plant canopy which is wrapped by filter paper. These ionized particles are sprayed by using nozzle with high pressure.

IV. RESULT AND DISCUSSION

One of the most important indexes to evaluate the effectiveness of electrostatic spraying is the charge-to-mass ratio. Generally speaking, the higher the charge-to-mass ratio, the more effective the electrostatic spraying should be. The test facility involves a bucket for collecting droplets, a micro-ampere meter for measuring the electric current and an insulated frame. The charge could be determined by measuring the current with the micro-amperemeter and the mass rate was determined by collecting spray liquid for a specified time. The charge-to-mass ratio was calculated by dividing the current by the mass rate. Charge-to-mass ratio was measured in three different position (1.5m, 3.0m, 4.5m) from nozzle tip and different voltages (1kV to 7kV) with a certain spraying parameters. The figure showed that the Q/m rises as the charging voltage increases and it goes down in a lower descent rate as the distance increases. This means that the charged droplet still carry charge at distant spots.



(h)

The spraying breadth experimental results showed that electrostatic spraying could increase spraying breadth and averagely increase spraying breadth to 0.5m (Table 1). The reason is that charged droplets will repel each other exerted by the like charges.

Mode Of Spraying		Spray Breadth (m)						
		1m	1.5m	2.0m	2.5m	3.0m	3.5m	4.0m
1	Non Electrostatic	0.5	0.8	1.01	1.2	1.4	2.4	3
2	Electrostatic	0.7	0.9	1.3	1.5	2	3.5	4.2

(i)

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V. CONCLUSION

An attempt has been made to characterise the performance of uniform distribution and deposition efficiency of the droplets on the plant canopy. It has been seen from the experiments that as the voltage is increased the charge to mass ratio is also increased and hence electrostatic force is increased due to that droplets can be found on front as well as back side of the target plant. It was also been observed that their should be uniform and thin distribution of pesticides on the target. Due to voltage applied to the system the coverage rate of fluid is also increased and that was shown by the increased spray breadth.

Finally due to this method we can reduce the wastage of pesticide as fall rate of pesticides on the soil or earth is decreased. Also soil pollution and environmental pollution also decreased.

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