Chapter 5
Fundamentals of Electrostatic Spraying:
Basic Concepts and Engineering Practices

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ABSTRACT

The desired attributes of electrostatic spraying are uniform deposition onto both directly exposed or obscured crop surfaces which minimize the off-target losses of active ingredients to soil, water, atmosphere and provide more effective and economical pest control. This chapter presents an overview of electrostatic spraying technologies in the field of agriculture emphasizing the key role of advanced electrostatic instrumentation and chronicles the scientific innovations in the parlance of providing cost effective and reliable commercial systems along with an insight on the needs of future research perspectives and directives. It is aimed primarily at a familiarization with spraying concepts and engineering practices. This text is to bridge the knowledge and experience gap among researchers and technology developers and the people involved in electrostatic processes applied to agriculture and food processing. It will also introduce the engineering aspects of design and development of an electrostatic spraying nozzle for agricultural applications.

INTRODUCTION

Air-assisted electrostatic sprayers are advanced agri-instruments for efficient use of pesticides to agricultural crops, orchards, plants, trees etc. The electrostatic spraying technique is all about reducing the use of pesticide by increasing the efficiency and bio-efficacy. Bio-efficacy is a measure of the biological efficacy of an active ingredients of agro chemical such as insecticide etc. The methods used to perform the function of bioremediation are known as bioremediators. Electrostatic spraying is to be the one

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among the available spraying techniques in precision agriculture and food processing. For example, the electrostatic spraying technique can be used for protective biomaterial coatings to fruits and vegetables for resistance towards microbial attacks, to enhance the transportation life, to control spoilage microorganisms, antimicrobial sprays for enhanced food safety etc. It is a method which reduces the environmental pollution by reducing contamination to soil as well as air. In totality, it reduces the chemical consumption which is used indiscriminately through conventional methods such as pedestal-mounted sprayers, the high pressure spray guns, the hand pressure swirl nozzles and the consecutive high volume spraying systems etc. The trans-disciplinary aspects of the embryonic field of electrostatic spraying have provided a major motivation to agricultural and food processing researchers for the development of novel techniques for spraying liquid pesticides to crops and orchards, protective coatings to food and food packaging, in addition to other applications of sprays to industrial, manufacturing and transportation, medical facilities and devices etc. This chapter is to be one among the motives behind the renewed curiosity in the usage of the electrostatics in liquid based spraying.

Although, organic measures for crop protection are being preferred, chemical intervention is still the fastest and most economical way for crop protection. However, due to lack of awareness and ignorance, pesticides are being used indiscriminately leading to side effects on human health and ecosystem. Electrostatic method of pesticide application reduces off-target drift, environmental pollution and human health risks and increases the bio-efficacy and mass transfer efficiency onto the biological surfaces of crops and trees with uniform back deposition. Law, (1978); Jia, Xue, Qui, & Wang, (2013) explained the design and development of induction based electrostatic sprayer for agricultural usage and evaluated the performance. So far, the equipment available in the market are uncontrolled in terms of spraying variability. Pesticide application control, targeted pesticide delivery and variable pesticide spraying are the key to improve operation quality, reduce chemical waste, environmental pollution and operational costs. This entices to develop a sensing mechanism which would discriminate between the presence and absence of pesticide application surfaces. He, Yan, & Chu, (2003) developed the automatic target detecting air-assisted electrostatic orchard sprayer. In this spraying system, the sensing mechanism is based on infrared proximity sensors which determine the presence and absence of target to be sprayed. Other than infrared proximity sensors, ultrasonic sensor mechanism is another substitute for target detection and canopy mapping. Sensory attributes stipulate a good approximation of target and canopy mapping for targeted delivery of pesticides to actual target. Automation and mechanization with respect to agricultural pesticide spraying is one of the naive research topics in the present scenario.

The last decade has witnessed the application of existing electrostatic techniques to various fields accompanied with rapid improvements of the spraying technology. Zhang, Srirama, & Mazumder, (2007) have worked on a new approach in signal processing and sampling which shows that electrostatic applications have gone beyond the earth and reached to Lunar and Mars missions. Space research needs electrostatics in dust and particle control. Mazumder et al., (2006); Hamid, & Atan, (2008); Ghayempour & Mortazavi, (2013); Khan, Maan, Schutyser, Schroën, & Boom, (2013) ; Zhang, Kobayashi, Uemura, & Nakajima, (2013) have shown the numerous applications of electrostatic spraying to various fields such as agriculture, medical, transportation, painting and industrial applications, though agriculture remained the main area of research during the last decade. Electrostatic application to agricultural pesticide spraying has revolutionized agriculture farming scenario by making advances and developments via off-target pest control to increase bio-efficacy and deposition efficiency. There is also an increase in deposition

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