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# Before Focusing on the Last Target, Think About the First Barrier

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## PREFACE

We all in the agricultural field need to spray pesticides, fertilizers, growth regulators or called plant hormones. We usually think about the target tissue, organ or organelles but do not give enough attention about the first barrier of the applied chemical. Farmers could have ample information about the dose, the stage of plant development or even the pH of the spray solution. These above information could be written on the stock solution package. However, we must know that it is not enough to just spray and pray since we might not take into consideration the actual amount that penetrated the barrier that covers the above ground canopy which is covered by a thin or thick cuticle. The penetration of sprayed chemicals across the plant cuticle is via the diffusion mechanism [1].

The cuticle is not only just the waxy outermost layer that we can observe easily on the red Delicious apple fruit. This whitish layer is only the epicuticular waxes **(Figure 1)**. However, the cuticle is scientifically described as the cuticular membrane that consists of many layers that have a hydrophobic nature. They are called the cuticle proper, the cuticular layer which has many protrusions that extend between the epidermal cells or in some plants. It extends to surround the epidermal cells. Such cuticular layer has many embedded wax platelets that are very resistant to penetration of sprayed materials. Fortunately, some fruit cuticles possess few natural cracks or sometimes very tiny channels called the micro-channels or even some lenticels representing a physical path in the cuticle structure.

The epicuticular wax plays very important roles **(Figure 2)** in reducing water loss, controlling gaseous exchange, restricting losses of nutrients and retaining traces of foliar applied chemicals. It is also a good micro-habitat for fungal pathogens. Such thin waxy layer can also reflect some incident radiations. The rate of movement and transport across that cuticular construction depends on many factors since it is a diffusion mechanism. These factors are governing the actual penetration process reported by Fick's Low [2] such as temperature, partition coefficient of chemicals in the sprayed droplets, radius and tortuosity of the cuticular-layer micro-spaces and the concentration gradient between sprayed solution and the internal solution in the extracellular spaces between cells. Thus, it seems a difficult task to diffuse the desired compound through the cuticle. The embedded waxes or also called the intra-cuticular waxes are very tough to penetrate. It is not surprising to find a thin cuticle as in ripe tomato fruit more resistant to diffusion of sprayed chemicals than that of the thicker apple fruit cuticle [3-10].

This information must be considered when taking the decision to spray at a certain stage of fruit development in order to get the expected results. Many farmers rush into applying a second and a third spray to see the outcome they are after such as early coloration or ripening or acceleration of the harvest time before the frost season. Chemicals that release ethylene inside the tissue such as the plant growth regulator called ethephon (or Ethrel) have a very hydrophilic nature with low ability to penetrate the hydrophobic-cuticular layers. The repeated application to increase its efficacy might lead to more abscission and shorten the storage life of fruit whether during the cold storage or at ambient temperature on the shelf. The use of surfactants along with sprayed chemicals is thought about some growers. However, these surfactants do not increase the actual diffusion but rather increase the contact angle of sprayed droplets and reduce the surface tension of sprayed solution drops. In some cases, it was helpful to prolong the drying time of sprayed solutions by adding small amount of glycerol [1]. It was also beneficial to incorporate some ethanol in the sprayed formulation since it was found that

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ethanol enhanced the penetration of Ethrel under field conditions [3]. It was an important finding that ethanol did not induce a permanent change in the cuticle structure by Farag [1] from his transport studies on the penetrability of Ethrel through the isolated cranberry fruit cuticle. In some plants, the presence of cellulosic micro-fibrils that could branch out across the cuticular layer would be very helpful in enhancing the translocation of sprayed compounds with hydrophilic nature.

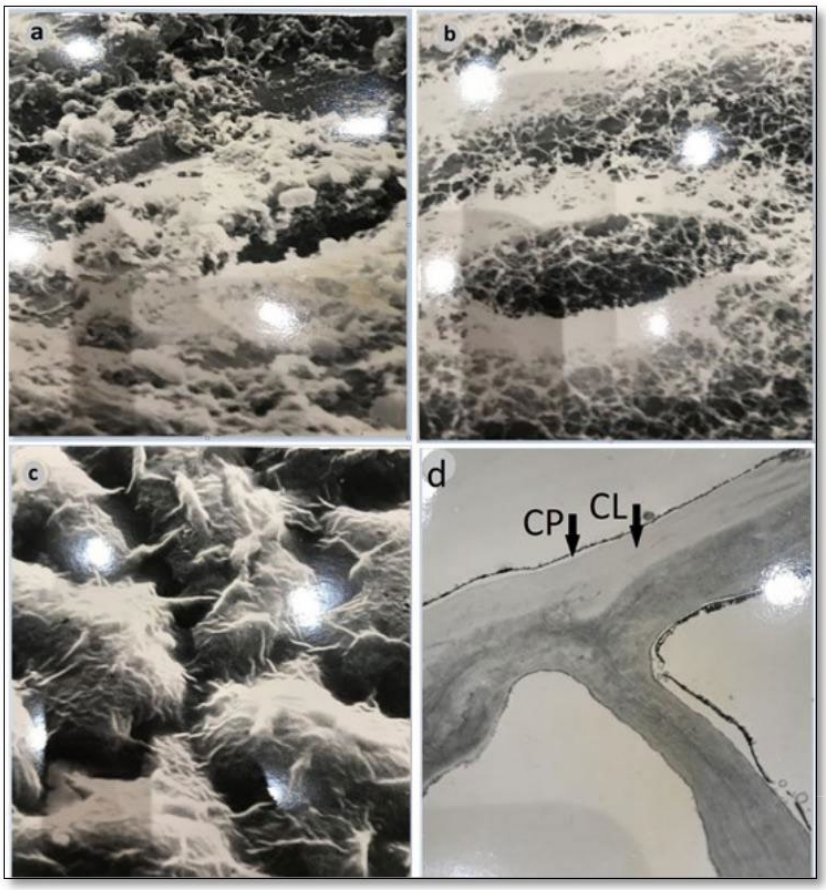


**Figure 1.** Scanning electron micrographs of the cranberry leaf cuticle showing the initiation of the epicuticular wax deposition (a), followed by the full deposition of this waxes even next to the sunken stoma (b), then the close-up photo for the initiation of the epicuticular wax deposition (c), and finally the transmission electron micrograph of the leaf cuticle showing the cuticle proper (CP) and the cuticular layer (CL) of the cranberry leaf cuticle (b) [1].

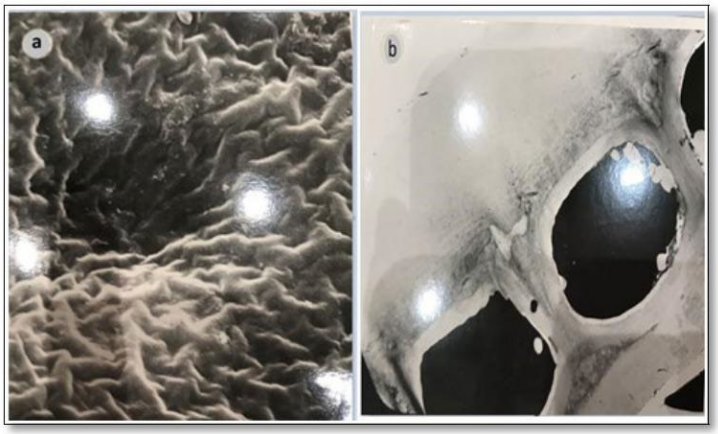


**Figure 2.** Illustration of deposition of waxes at early stages of the epicuticular waxes formation on the cranberry fruit as depicted by scanning electron micrograph (a), then transmission electron micrograph showing various layers of the fruit cuticle surrounding the epidermal cells (b) [1].

Fore mentioned information emphasizes the significance of applying sprayed chemicals in formulations that enhance the diffusion and reduce the cost and reduce environmental pollution. No wonder, it has been very important to widely use a natural compound called Lysophosphatidyl Ethanolamine (LPE) as a plant and fruit growth regulator that has been granted the approval of Food and drug Administration in the USA and has been applied in countries such as the USA, Spain, Portugal, Turkey, South Africa, South Korea and Egypt. The USA Patent Office granted four patents to the first author of this article [6]. Such natural compound is a lysophospholipid with a hydrophobic nature and mitigates the adverse effects of Ethrel. At a certain concentration, LPE stimulates ethylene production without an accompanied rise of respiration rate [5]. Moreover, LPE was able to avoid the adverse effects of ethephon on enhancing ripening of tomato without damaging the leaves [8]. It also alleviated stresses of some pesticides or environmental ones. In following studies, Ryu et al. [9], showed that LPE is the first inhibitor of the senescence enzyme called phospholipase D. In addition, LPE caused novel effects on plants and fruits such as retarding and delaying tissue senescence while enhancing fruit coloration [10,11-17] and extending their keeping quality [8,13,14] and extended the vase life of cut flowers [15].

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