Agri JOURNAL WORLD
www.journalworlds.com
AGRI JOURNAL WORLD
VOLUME 4 ISSUE 9 SEPTEMBER, 2024

EFFECT OF SURFACTANTS ON PLANT DISEASE MANAGEMENT

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ABSTRACT

Volatile organic compounds (VOCs) are crucial plant responses to biotic and abiotic stimuli, emitting signals that convey the physiological state of the plant. Research on plant-plant interactions primarily focuses on defensive reactions in recipient plants, but VOCs also influence hormone communication and metabolism, affecting overall plant fitness. This summary highlights how VOC exposure impacts receiving plants, detailing key chemical cues, VOC absorption, conversion, and surface adsorption. Significant changes in growth, reproduction, and metabolism are discussed, emphasizing the need for further research on whole plant responses to fully understand VOC effects.

KEYWORDS: Disease management, Spreading property, Surfactant solution

INTRODUCTION

Surfactants help transfer pesticide compounds to their intended targets in plants, vectors, or diseases more easily. They are typically employed in conjunction with pesticides in plant disease management. Surfactants are an essential or fundamental part of various consumer and industrial formulations. Such organic amphiphilic molecules show exclusive potency to adsorb in aqueous or non-aqueous solution at the self-aggregate, self-assemble, interface, or in different phases. Surfactants may not only effectively reduce the surface tension of the solution but also dissolve the epicuticular waxes on the leaf surfaces. Effective agrochemical spraying on plants and seeds and minimum wastage is an important issue with respect to crop yield, storage, and mitigation of environmental pollution. Most agrochemicals are applied as liquids sprayed through nozzles and the volume ranges from 1000 to 1 litre per hectare and droplet diameter varies from 50 to 400 μm. In agrochemical applications, parameters such as droplet size, their impact and adhesion, spreading, and retention are of primary importance in ensuring maximum capture by and adequate coverage of the target surface.

Recently, Smith, Askew, Morris, Shaw, and Boyette studied in great detail the effect of droplet size and leaf morphology on pesticide spraying and deposition. Young, Thacker and Curtis studied the effect of three adjuvants on the retention of insecticide on cabbage leaf based on the physical properties of the formulation e.g., static surface tension and viscosity. The spreading velocity is often an important criterion based on which the efficiency of surface-active substances (surfactants) can be estimated. In general, when a liquid drop is placed on a solid surface, either it spreads over the surface, that is, it completely wets the surface or it forms a finite contact angle with the surface. If the contact angle is between 0° and 90°, the situation is referred to as partial wetting. However, if the contact angle is larger than 90°, the liquid does not wet the surface and the situation is referred to as non-wetting (Fig. 1).

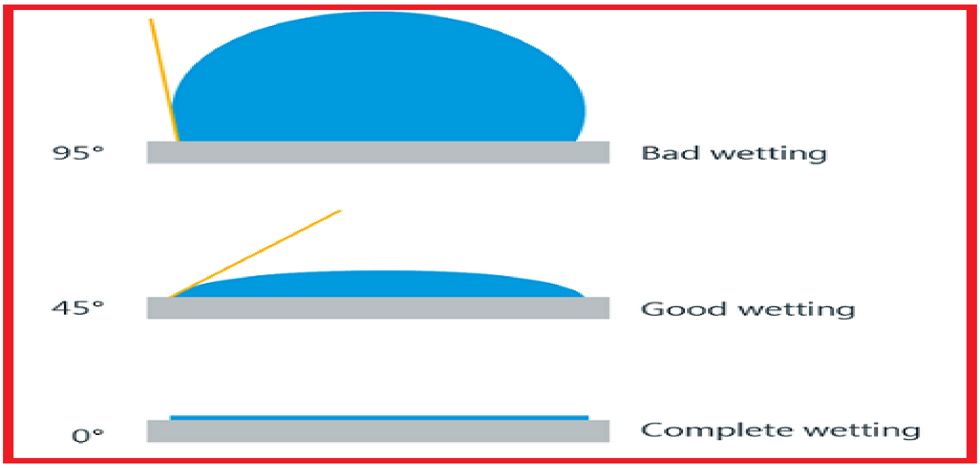

Fig. 1. Different wetting situations. (a) Complete wetting case: a droplet completely spreads out and only a dynamic contact angle can be measured, which tends to zero; (b) Good wetting case: the final static advancing contact angle is between 0° and 45°; (c) Bad wetting case: contact angle is larger than 90°.

SPREADING OF AQUEOUS SURFACTANT SOLUTIONS ON HYDROPHOBIC SURFACES

Most of the natural and artificial surfaces are poorly wetted or are not wetted at all by water and aqueous solutions (Fig. 2). These surfaces are referred to as low-energy surfaces or hydrophobic surfaces. These surfaces are referred to as low-energy surfaces or hydrophobic surfaces. However, various technological processes require aqueous solutions to spread out on originally hydrophobic surfaces (Tadros, 2005).

SPREADING

Many leaf surfaces are non-wettable by nature. This is due to the predominantly hydrophobic nature of the leaf surface, which is usually covered with crystalline wax of straight chain paraffinic alcohols in the range of 24–35 carbon atoms. In agrochemical application it is important to cover the leaf surface with a minimum quantity of liquid i.e., thickness of the film of the agrochemical should be small.

It is seen that the spreading factor for water increases with the addition of tergitol, which is non-ionic, the compared with the ionic surfactants HTAB and SDBS.

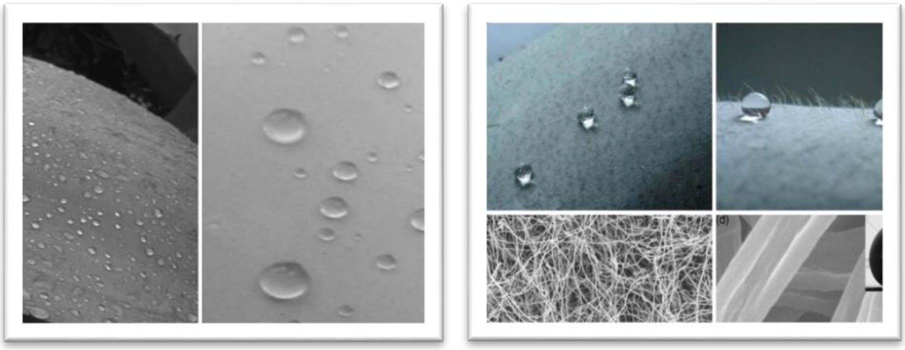

Fig. 2. Rain droplets on the leaf of an Agavaceae plant (left). Water droplets deposited from a sprayer on the surface of a polypropylene film (right) (Ivanova and Starov, 2011).

BIMODAL KINETICS OF SPREADING OF SURFACTANT SOLUTIONS

One of the widely used methods to analyse the mechanism of spreading of surfactant solutions is to fit the experimental data by the power law R ~ tn. This method is widely used to analyse wetting by pure liquids. Briefly, the relationship between the spreading/power exponent, n, and the corresponding mechanism is as follows. In the case of small droplets and complete spreading, n = 0.1 (Tanner's law), showing the capillary-driven spreading regime (Tanner, 1979), or n = 0.14, the same regime but based on a molecular approach to the dissipation of energy. Svitova et al., 2001 reported that, two stages of complete spreading of C12EO3 surfactants and trisiloxanes TEO8 and TEO12 on graphite. For polyoxyethylene alcohols at C > cac (cac is the critical aggregation concentration; critical wetting concentration > cac) the first and second stages were described by the power laws with n = 0.1 and n = 0.4, respectively. In the case of trisiloxanes at C > cwc the authors found higher spreading exponents: n = 0.2 and n = 0.5, respectively. Only one-stage partial wetting was observed for both types of surfactants at C < cmc/cwc.

Some authors do not report the bimodal kinetics of spreading of the surfactants studied, but they provide the evolution of the spreading exponents with concentration (Zhang et al., 2009), which is useful for the identification of the driving forces responsible for spreading in a certain concentration range of surfactants.

SURFACTANTS USED IN DIRECT PLANT DISEASE CONTROL

The use of the non-ionic surfactant Agral 90 to inactivate the zoospores of Olpidium brassicae, the vector of the big vein virus of lettuce and the melon necrotic spot virus of cucumber, was one of the early investigations demonstrating the effects of surfactants on a plant pathogen (Jibrin et al., 2021). It was assumed that the disease reduction in lettuce was caused by adding the fungicide benzimidazole to the recirculating nutrient solution of a hydroponic system, therefore this initial discovery was fortunate. More proof that surfactants are effective against zoospores comes from recent research. Within one minute of being exposed to 10 µg/ml of the alkoxylate non-ionic surfactant Atplus MBA1301, zoospores of Phytophthora cryptogea, the agent responsible for brown root rot of witloof chicory, exhibited both lysis and motility inhibition. Plant bacterial infections have been demonstrated to be exacerbated by the non-ionic organosilicon surfactant Silwet L-77, which is extensively utilised in field crop production (Brosset and Blande, 2022).

CONCLUSIONS

Wetting and spreading phenomena occurring in the presence of non-ionic surfactants on hydrophobic solids and thin aqueous layers are reviewed. Special attention is paid to wetting/spreading/penetration of non-ionic hydrocarbon and organosilicon surfactants that are widely used in industrial and scientific applications. In the presence of a small quantity (0.1 wt.%) of tergitol in water, the static contact angle decreases and thus the adhesion ((Eo - Es)/Es), spreading factor, and surface coverage factor of droplets on all the leaf and seed surfaces increases. The effects of surfactants on the plant microbiome, the lowest level of harmful pesticide residue, and their application in improving plant disease control are all poorly understood. The next step in enhancing plant disease management and guaranteeing environmental safety is anticipated to involve investigating green surfactants and other biosurfactants and incorporating them into chemical plant disease control.

REFERENCES

Brosset, A., and Blande, J. D. (2022). Volatile-mediated plant–plant interactions: volatile organic compounds as modulators of receiver plant defence, growth, and reproduction. *Journal of Experimental Botany*, 73(2), 511-528.

Jibrin, M.O., Liu, Q., Jones, J.B. and Zhang, S., (2021). Surfactants in plant disease management: A brief review and case studies. *Plant Pathology*, 70(3), pp.495-510.

Tanner, L.H. (1979). The spreading of silicone oil drops on horizontal surfaces. *Journal of Physics D: Applied Physics* 12; 1473.

Ivanova N.A. and V.M. Starov, (2011). Wetting of low free energy surfaces by aqueous surfactant solutions. *Current Opinion in Colloid & Interface Science* 16; 285.

Tadros, T.F. (2005). Applied Surfactants: Principles and Applications. Wiley-VCH, Weinheim, Germany.

Zhang Y. and F. Han, (2009). The spreading behaviour and spreading mechanism of new glucosamide-based trisiloxane on polystyrene surfaces. *Current Opinion in Colloid & Interface Science* 337; 211.

How to cite:

Mondal, A., Sadhu, S., and Dhali, A. (2024). Effect of surfactants on plant disease management. Leaves and Dew Publication, New Delhi 110059. *Agri Journal World* 4(9): 1-4.

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