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Organosilicone Compounds in Agriculture

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INTRODUCTION

Agriculture is a significant part of the global economy as well as a major source of food (Shahid, 2023; Shahid *et al*., 2024). Pesticides have been used in agriculture by farmers to control the pests, diseases and weeds (Shahid and Khan, 2016). Nearly one-third of the agricultural products are being produced currently, depending upon the use of pesticides. Organosilicone compounds, characterized by their unique silicon-carbon (Si-C) bonds, have transformed agriculture by boosting crop performance, pest resistance and sustainability. As fungicide additives, they improve efficacy through enhanced retention, reduced surface tension, and rain resistance (Shahid *et al*., 2023). Studies show their synergistic effects in managing powdery mildew disease of grape, wilt diseases and universal pathogens e.g. *Sclerotinia sclerotiorum*. Silicone additives, particularly polyether-modified trisiloxane surfactants, improve wettability, spreadability, and permeability. Their adoption reduces pesticide use, minimizes residues, conserves water, and increases productivity while lowering labor demands, making them essential for sustainable and efficient farming.

Organosilicone compounds, known for their unique silicon-carbon (Si-C) bonds, have attracted considerable interest in agriculture due to their ability to enhance crop performance, improve pest resistance, and promote environmental sustainability. By bridging organic and inorganic chemistry, these compounds offer distinctive properties ideal for various agricultural applications. One notable use of organosilicone compounds is as fungicide additives. They enhance the efficacy and efficiency of fungicides by increasing solution retention on plant surfaces, lowering surface tension, and improving resistance to rain-induced washing. Research has consistently demonstrated improved fungicide performance when organosilicone compounds are included in formulations.

In a field efficacy trial evaluating fungicides against grape powdery mildew scientist have found that the "jiexiaoli" synergist significantly enhanced the performance of 29% isopyrazam·azoxystrobin 29% SC. Treatments using this synergist showed superior efficacy compared to single-agent treatments, even with a 30% reduction in the agent's usage. Similarly, Ren *et al*. (2013) found that Prochloraz, combined with organic silicone, achieved an average control effect of 80% against *Sclerotinia sclerotiorum*, compared to 74% with Prochloraz alone. This indicates that organic silicone contributes to synergism in controlling *Sclerotinia sclerotiorum*. Additionally, silicon-based additives have demonstrated comparable synergistic effects with various agents, including carbendazim, triadimefon, chlorpyrifos 30% EW, and ZJ0712 SC, in managing pests and diseases while effectively reducing the required quantities of these agents.

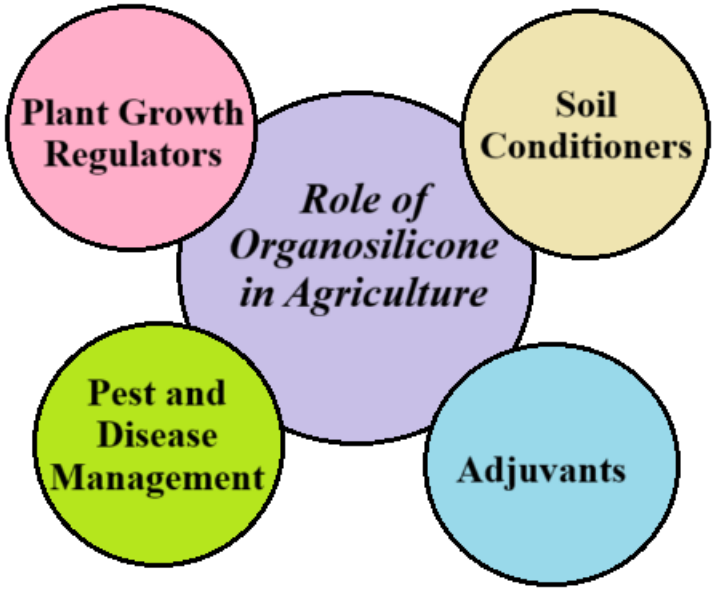

Figure 1. Picture showing role of Organosilicone in agriculture.

Silicone additives are polyether-modified trisiloxane nonionic surfactants commonly used in agriculture. These high-performance, environmentally friendly surfactants possess ultra-low surface energy and exhibit excellent properties such as wettability, spreadability, permeability, and compatibility. They also offer benefits like foam formation control, including stabilizing and inhibiting foam. Silicone additives can be incorporated into fungicides, insecticides, herbicides, foliar fertilizers, and other agricultural products. Their use significantly enhances the efficiency and effectiveness of chemical applications, reduces pesticide usage by 30-50%, minimizes pesticide residues, conserves water, lowers labor demands, and boosts overall productivity. Widely adopted in agricultural production, these additives have revolutionized pesticide formulation and application technology. The spreading of aqueous solutions due to the organosilicone polymers gives total wetting as measured by low contact angle on leaf surfaces while conventional surfactants provide for less spreading as indicated by higher contact angles. In addition, organosilicone compounds have been proven to accelerate the rate and amount of uptake of agricultural active ingredients into plants, thereby enhancing the efficacy of agricultural active ingredients, including rain resistance in some cases.

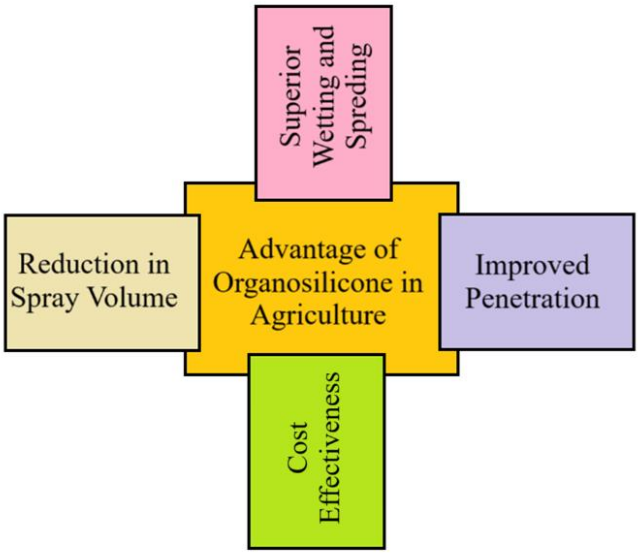

Figure 2. Picture showing advantage of organosilicone in agriculture.

CONCLUSION

Organosilicone compounds have emerged as game-changers in modern agriculture, offering unparalleled benefits across a wide range of applications. From enhancing the efficacy of fungicides and pesticides to reducing chemical usage and promoting environmental sustainability, these compounds have demonstrated their ability to address critical challenges in agricultural practices. Their unique chemical properties, such as ultra-low surface tension, excellent wettability, and improved uptake of active ingredients, make them indispensable tools in advancing crop protection and productivity. As research and development in this field continue, the role of organosilicone compounds in sustainable agriculture is expected to expand, further revolutionizing pesticide formulation and application technology while contributing to global food security and environmental conservation.

Conflict of Interest

All the authors declare no conflict of interest.

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