

A Monthly e Magazine  
ISSN:2583-2212

April, 2026 Vol.6(4), 941-947

Popular Article

## Silver thiosulphate in Horticulture: A review

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[doi.org/10.5281/ScienceWorld.19658515](https://doi.org/10.5281/ScienceWorld.19658515)

### *Abstract*

Silver thiosulphate (STS) is a widely studied anti-ethylene compound in horticulture used to regulate flowering, extend floral longevity, and manipulate sex expression in crops such as cucurbits, cassava, and ornamentals. Its role as an ethylene inhibitor makes it a critical tool in breeding, hybrid seed production, and postharvest flower management.

### **1. Introduction**

Ethylene is a plant hormone central to processes such as flower senescence, fruit ripening, and sex determination. While beneficial in certain contexts, excessive ethylene activity can lead to premature flower drop, reduced floral longevity, and imbalanced sex expression in crops (Shahram Sedaghatthoor et al.,2020). Silver thiosulphate (STS), a complex of silver nitrate and sodium thiosulphate, acts as a potent ethylene inhibitor by binding to ethylene receptors and preventing their activation.

In horticulture, STS has been extensively applied to cut flowers and ornamentals to delay wilting, petal abscission, and senescence, thereby extending vase life and improving marketability. In agriculture, particularly in cucurbits such as cucumber and melon, STS is used to induce male flowers in gynoeocious lines, ensuring pollen availability for hybrid seed production. Similarly, in cassava breeding programs, STS enhances flower production and longevity, overcoming natural reproductive limitations (Veen et al., 1989).

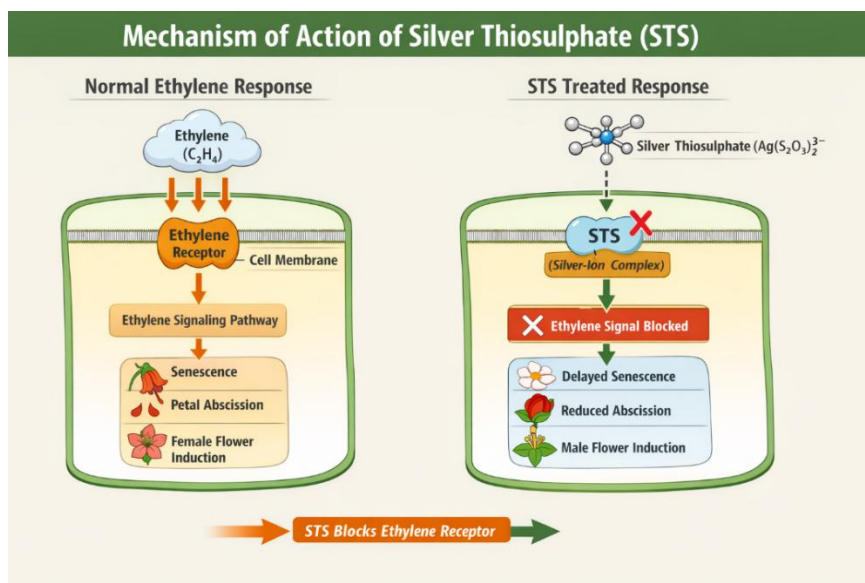


## 2. Mechanism of Action – Ethylene Inhibition

Ethylene is a gaseous plant hormone that regulates many developmental processes, including fruit ripening, flower senescence, and sex expression. STS, a complex of silver nitrate and sodium thiosulphate, exerts its effect by binding to ethylene receptors in plant tissues, preventing ethylene molecules from activating them. This competitive inhibition blocks downstream signaling cascades (Figure 1) that would otherwise trigger flower wilting, petal abscission, or female flower dominance. In cucurbits, where ethylene promotes female flower formation, STS shifts the balance toward male flower induction, ensuring pollen availability for hybrid seed production. In cassava, STS application has been shown to increase flower production and longevity, overcoming natural reproductive limitations that hinder breeding programs (Hyde et al., 202).

### Physiological Outcomes in Crops

By disrupting ethylene perception, STS effectively delays senescence and enhances reproductive success. In cut flowers such as carnations and roses, STS treatment prevents premature wilting and petal drop, extending vase life and improving marketability. In cucurbits, foliar sprays of STS induce staminate flowers in gynoecious lines, a critical step in hybrid seed production. In cassava, STS reduces flower abortion and increases reproductive prolificacy, thereby supporting breeding efficiency. Theoretical models further confirm that STS interacts with ethylene released from its precursor (ACC), stabilizing floral structures and prolonging reproductive phases (Veen et al., 1986).



**Figure 1: Mechanism of action of silver thiosulphate**



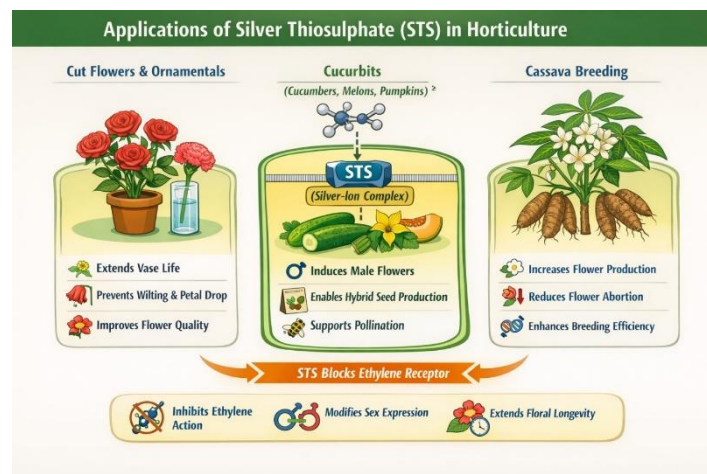
### 3. Applications in Horticulture

Silver thiosulphate (STS) is widely used in cucurbits like cucumber to regulate sex expression, promote male flower formation, and improve hybrid seed production. Its application helps balance male and female flowers, ensuring better pollination and higher yields (Figure 2).

#### 3.1 Cut flowers

Silver thiosulphate (STS) has been extensively applied in the floriculture industry to improve the postharvest quality of cut flowers and ornamentals. As an ethylene action inhibitor, STS prevents premature wilting, petal abscission, and floral senescence, which are common problems in ethylene-sensitive species such as carnations, roses, and chrysanthemums. Studies have shown that STS treatment significantly extends vase life in carnations by reducing ethylene-induced petal inrolling and wilting, thereby enhancing their commercial value (Veen, 1979; Reid et al., 1989). Similarly, in roses, STS application delays petal drop and bud abortion, ensuring longer display periods and improved consumer satisfaction (Macnish et al., 2000).

Beyond cut flowers, STS has also proven effective in potted ornamentals, where it helps maintain foliage quality and delays leaf yellowing. Research on chrysanthemums demonstrated that STS, often in combination with polyamines such as putrescine, prolongs floral longevity and maintains ornamental appeal (Nowak & Rudnicki, 1990). The compound's ability to block ethylene perception makes it a cornerstone of postharvest management practices in the global floriculture trade. However, its use requires careful dosage and handling, as excessive concentrations may cause phytotoxicity and silver residues pose environmental concerns (Reid & Jiang, 2012). Overall, STS remains one of the most reliable tools for enhancing the shelf life and marketability of cut flowers and ornamentals.



**Figure 2: Applications of Silver thiosulphate in horticulture**



### **3.2 Cucurbits**

Silver thiosulphate (STS) has been widely applied in cucurbits such as cucumber, melon, and pumpkin to regulate sex expression and facilitate hybrid seed production. Ethylene plays a central role in promoting female flower development in cucurbits, but for breeding purposes, especially in gynoecious lines that produce only female flowers, male flowers are required to provide pollen. STS acts as an ethylene inhibitor, binding to ethylene receptors and preventing their activation, thereby shifting the balance toward male flower induction. Research has demonstrated that foliar sprays of STS in gynoecious cucumber lines successfully induce staminate flowers, enabling breeders to maintain these lines and produce hybrid seeds efficiently (Robinson et al., 1978; Trebitsh et al., 1987).

In addition to cucumbers, STS has shown effectiveness in melons and pumpkins, where it helps balance male and female flower production under varying environmental conditions. By reducing ethylene sensitivity, STS prevents excessive female flower dominance, ensuring adequate pollen availability for pollination and fruit set. This application is particularly valuable in controlled environments such as polyhouses, where hybrid seed production is a priority. Studies confirm that STS, often used in combination with gibberellic acid (GA<sub>3</sub>), enhances reproductive success and seed yield in cucurbits by promoting synchronized flowering and improving pollination efficiency (Rudich et al., 1972; Peterson & Anhder, 1974). Thus, STS remains a cornerstone in cucurbit breeding programs, supporting both commercial seed production and scientific crop improvement efforts.

### **3.3 Applications of STS in Cassava Breeding**

Cassava (*Manihot esculenta* Crantz) is a staple crop for millions in Africa, Asia, and Latin America, but its breeding is hindered by poor and inconsistent flowering. Ethylene plays a major role in flower abortion and senescence, limiting reproductive success. Studies have shown that STS application significantly increases flower production and longevity in cassava, making it possible to generate more reliable seed sets for breeding programs. Hyde et al. (2019) demonstrated that STS-treated cassava plants produced more flowers and retained them longer, directly addressing one of the biggest challenges in cassava improvement (Hyde et al., 2020).

### **3.4 Breeding Efficiency and Practical Use**

Beyond simply increasing flower numbers, STS enhances the efficiency of cassava breeding by improving flower retention and reducing abortion rates, which are critical for successful crossing. Guan (2016) reported that optimizing STS application protocols—such as timing, concentration, and method—led to better flower retention and improved outcomes



in controlled breeding programs . Furthermore, recent work combining STS with benzyladenine and pruning has shown additive effects, not only increasing flower numbers but also feminizing cassava flowers, thereby improving the chances of seed production and genetic recombination (Oluwasanya et al., 2023). These findings highlight STS as a cornerstone in modern cassava breeding, enabling researchers to overcome reproductive barriers and accelerate genetic improvement for food security.

**Table 1: Comparative Benefits of silver thiosulphate in horticulture**

Crop/Use	STS Effect	Impact
Cucurbits	Induces male flowers	Hybrid seed production efficiency
Cassava	Increases flower longevity	Better breeding success
Ornamentals	Prevents wilting & petal drop	Extended vase life
Potted plants	Delays senescence	Improved marketability

#### 4. Key Risks in Horticultural Use

**4.1 Phytotoxicity:** High concentrations or repeated applications of STS can damage plant tissues, causing leaf burn, reduced vigor, or abnormal growth. This risk is particularly relevant in sensitive ornamentals and cucurbits where dosage must be carefully calibrated.

**4.2 Environmental contamination:** Silver ions from STS are highly toxic to aquatic life and soil invertebrates, posing risks if wastewater or residues enter natural ecosystems. The University of Hertfordshire’s pesticide database highlights that STS waste must not reach public sewers, as contaminated sludge can harm terrestrial biodiversity.

**4.3 Residue persistence:** Silver compounds can accumulate in soils, potentially altering microbial communities and long-term soil health. This raises sustainability concerns in intensive horticultural systems.

#### 5. Safety and Regulatory Considerations

**5.1 Human health:** While no significant direct health risks have been identified for workers handling STS solutions, protective measures (gloves, masks, controlled application) are recommended to avoid exposure.

**5.2 Regulatory oversight:** The European Food Safety Authority (EFSA) has reviewed sodium silver thiosulphate as a pesticide active substance, emphasizing the need for strict environmental safeguards and controlled application ratios (at least 1:8 silver to thiosulphate ions).



**5.3 Waste disposal:** STS residues must be disposed of responsibly, avoiding entry into water systems. Controlled collection and treatment are necessary to prevent ecological damage.

**Table 2: Practical Considerations in use of silver thiosulphate for Growers**

Risk	Impact	Mitigation
Phytotoxicity	Leaf burn, reduced vigor	Use optimized concentrations and timing
Aquatic toxicity	Harm to fish, invertebrates	Prevent runoff and wastewater contamination
Soil accumulation	Altered microbial balance	Rotate crops, monitor soil health
Regulatory compliance	Legal restrictions	Follow EFSA/local guidelines

## 5. Conclusion

Silver thiosulphate has become a cornerstone in horticultural and agricultural practices, particularly in cucurbit hybrid seed production, cassava breeding, and ornamental flower management. By inhibiting ethylene, STS enhances reproductive success and postharvest quality. However, its use must be carefully managed to avoid phytotoxicity and environmental risks.

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