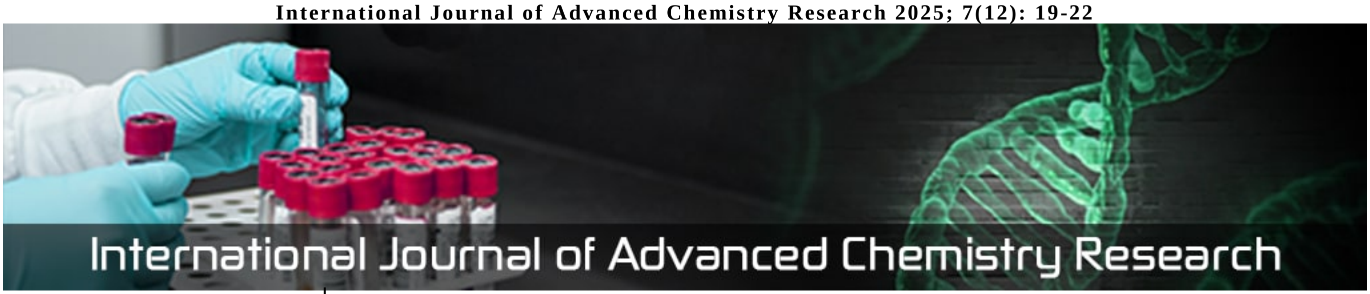

ISSN Print: 2664-6781
ISSN Online: 2664-679X
NAAS Rating (2025): 4.77
IJACR 2025; 7(12): 19-22
www.chemistryjournals.net
Received: 17-09-2025
Accepted: 19-10-2025

Md Sahid Hussain Aslam Laskar
Department of Zoology, Bishop Heber College, Tiruchirappalli, Tamil Nadu, India

Sudhakar S
Scientist, Plant Protection, ICAR-KVK, Idukki, Kerala, India

Kumari Saumya
Department of Life Sciences, Maharaja Agrasen Himalayan Garhwal University, Uttarakhand, India

Jabir Hussain
Department of Zoology, University of Science and Technology, Meghalaya, India

Sutirtha Gomes
Postgraduate Department of Microbiology, St. Xavier's College (Autonomous), Kolkata, West Bengal, India

Chhaya Singh
Department of Botany, Government Post Graduate College, Thalisain (Pauri Garhwal), Uttarakhand, India

Narra Abhiram Reddy
Department of Biotechnology, Bhavan's Vivekananda College of Science, Humanities and Commerce, Secunderabad, Telangana, India

Corresponding Author:
Sudhakar S
Scientist, Plant Protection, ICAR-KVK, Idukki, Kerala, India

Evaluating the effects of foliar potassium silicate application on small cardamom growth and physiology under drought stress

Md Sahid Hussain Aslam Laskar, Sudhakar S, Kumari Saumya, Jabir Hussain, Sutirtha Gomes, Chhaya Singh and Narra Abhiram Reddy

DOI: https://www.doi.org/10.33545/26646781.2025.v7.i12a.342

Abstract
An experiment was conducted at the Small cardamom plantation, Idukki, Kerala during 2021 -2024 summer (February-May) to evaluate the response of small cardamom crop to the foliar application of Potassium silicate under drought situation. The experiment was carried out using a Split-Plot arrangement according to the Randomized Complete Block Design (RCBD) with three replications. The main plots included irrigation intervals (T_1, irrigated every 15 days; T_2, irrigated every 10 days; and T_3, irrigated every 8 days), while the concentrations of potassium silicate fertilizer (1.5 gm S1, 2.5gm S2, and 5gm S3 ml liter-1 of distilled water), in addition to the control treatment S0, which was sprayed with distilled water only, allocated to the sub-plots. The T_3 irrigation interval showed the highest average pod yield with 5.42-ton ha-1, while the T_1 interval showed the lowest value for capsule yield at 4.23-ton ha-1. This was confirmed by the results of a study that found a significant increase in capsule yield for the plant under water stress.

Keywords: Potassium silicate, nitrogen fixation, phytohormone, water stress

Introduction
Small cardamom *(Elettaria cardamomum* Maton), popularly called the queen of spices, is second only to pepper, the king of spices. It is the world's third most expensive spice surpassed in price per weight only by vanilla and saffron (Williams and Olivia, 2014). India is the second largest producer of small cardamom and plays an important role in the international trade of cardamom. The yield of cardamom is highly dependent on prevailing climatic conditions as the cardamom plant requires intermittent spells of rain and good sunshine during the growth stage. Cardamom production in the country during 2018-20 was estimated at 29 thousand tonnes compared to 19 thousand tonnes in 2018-21. Cardamom cultivation is considered as a bed of roses with thorns, because both biotic and abiotic stresses play a vital role in lowering its productivity. Abiotic stresses such as rise in temperature, flood, drought and salinity have detrimental effect on yield of cardamom, among which, and drought was not a serious problem in previous years. But, now it has became a great threat for cardamom cultivation owing to the failure of monsoon and summer showers. Furthermore, the most effective way to utilize water and save it is to regulate the water given in each irrigation and determine the number of irrigations for each crop according to its needs during the growth stages and to ensure the highest productivity (Nielsen R L. 2002) [1]. An annual growth rate of eight to ten percent is anticipated for various spices in order to satisfy both domestic consumption and foreign export demand. In order to reach the goal, Spice productivity needs to be increased. Potassium is one of the nutrients that contribute to the production and quality of spices, and balanced nutrition is one of the key elements in increasing production. Due to its capacity to supply two essential elements, potassium (K^+), a primary macronutrient required for enzymatic activation and osmotic regulation Sardans and Peñuelas, and silicon (Si), a beneficial element known for improving structural integrity, water-use efficiency, and photosynthetic capacity, potassium

silicate (K_2SiO_3) has emerged as a multifunctional biostimulant. Although silicon's positive benefits have mostly been investigated under a variety of biotic and abiotic stress scenarios, there is mounting evidence that it can enhance crop performance even in ideal growth conditions. K_2SiO_3 application has demonstrated positive outcomes in crops such as *Camelina sativa* (Rad *et al.*, 2024) [16], wheat (Saudy *et al.*, 2023) [17], and tomatoes (El-Sayed *et al.*, 2022) [18], including enhanced biomass accumulation, enhanced chlorophyll production, and water regulation. According to Devi *et al.* (2025) [19], soaking the soil with 0.5% K_2SiO_3 was the most successful method, resulting in notable increases in plant growth and productivity. Additionally, seed priming and foliar spraying demonstrated favorable results, emphasizing K_2SiO_3 as a flexible input for resilient and sustainable crop development. Silicon has an effect on the physiological characteristics and the nutritional status of the small cardamom plantation under conditions of water stress, as it helped the plant to increase the moisture content of the tissues, and thus increased the accumulation of dry matter and the content of the leaves of chlorophyll pigment, and silicon improved the absorption of nutrients such as calcium and potassium (Cengiz Kaya L T, and Higgs D. 2006) [2]. Silicon also has an important role in increasing the resistance of sorghum plants to drought, as this experiment. However, limited research exists on the potential of biostimulant interventions especially K_2SiO_3 to improve cardamom growth and productivity under normal and drought conditions. Most available studies tend to focus on stress-induced improvements, thereby creating a critical knowledge gap in understanding the agronomic relevance of K_2SiO_3 in standard growing systems.

Materials and Methods

A field experiment was conducted to evaluate the effect of Potasium slicate, nutrients, growth regulators, anti-transpirants and compatible solutes against the drought stress at KVK, Idukki District, Kerala, using cardamom variety Green Gold (Njallani) during 2021-2024. Five foliar applications were given at 30 days interval during January and May. The experiment investigated the effect of the effectiveness of spraying with potassium silicate and water stress on the growth and yield of small cardamom plantation. The experiment was arranged in a Split-Plot design according to the Complete Randomized Block Design (R.C.B.D) with three replications.

Results and Discussion

The results indicate a significant effect of water stress levels, spray treatments with potassium silicates, and their interaction on the dry pod yield. The T_3 irrigation interval showed the highest average pod yield with 5.42 ton ha-1, while the T_1 interval showed the lowest value for grain yield at 4.23 ton ha-1. This was confirmed by the results of a study that found a significant increase in grain yield for the plant under water stress (Al-Samarrai *et al.*, 2013) [13]. In addition, the results showed that treatment S3, outperformed the other treatments in terms of the concentration of spray with potassium silicates and its effect on the grain yield with 5.42 ton ha-1. On the other hand, S2 showed the lowest average grain yield at 4.31 ton ha-1. Similarly, Xie *et al.* (2015) [12] found that silicon can improve a plant's tolerance to drought and salt by altering its physiology. Plants, particularly graminaceous ones like rice and sugarcane, benefit from silicon deposition in the apoplast, which fortifies leaf structure and helps them withstand stresses. Furthermore, under high salt conditions, silicon treatment increases photosynthetic efficiency, carbon dioxide fixation, chlorophyll content, and antioxidant activity, all of which boost plant growth. This confirms that potassium silicates increase crop productivity by increasing starch accumulation in green plastids and increasing the plant's ability to tolerate oxidative stress (Addaheri *et al.*, 2021) [14]. The results indicated a significant interaction between the two study factors. The T_3S3 interaction gave the highest average yield of 5.42 ton ha-1, while the interaction between level T_2 and the control treatment S0 gave the lowest average yield at 2.75 ton/ha. This was confirmed by a study that found a significant increase in grain yield under stress conditions when potassium silicates were added (Shaban *et al.*, 2013) [15]. According to Devi *et al.* (2024) [20], potassium silicate improves nutrient uptake, fortifies plant tolerance to unfavorable circumstances, and fosters general plant health and growth. It stabilizes agricultural productivity by successfully reducing abiotic stresses. It targets fungi and nematodes as a biocontrol agent, providing a sustainable substitute for synthetic pesticides with no adverse effects on non-target organisms.

Table 1: Effect of spraying with potassium silicate on water stress at 30 days interval during January and May

Water stress levels	Spray concentration with potassium silicate (liter-1 of distilled water)				Mean water stress
	S0	**S1 (**1.5 gm/L of water)	**S2(**2.5 gm/L of water)	**S3(**5 gm/L of water)	
T_1	16.21	18.21	19.27	18.21	18.20
T_2	15.20	17.12	18.10	18.51	18.21
T_3	16.14	16.20	18.75	18.20	18.51
Silicate mean	16.20	18.10	18.50	18.0	18.20
L.S.D 0.05	N.S	N.S	N.S	N.S	N.S

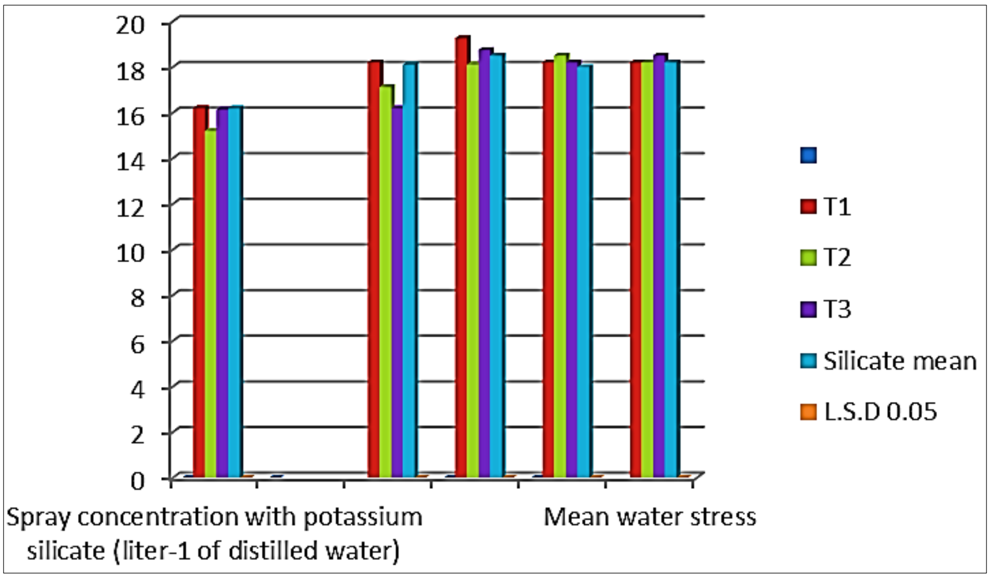

Fig 1: Effect of spraying with potassium silicate and water stress in small cardamom

Table 2: Effect of spraying with potassium silicate and water stress on the total dry pod yield (ton ha-1)

Water stress levels	Spray concentration with potassium silicate (liter-1 of distilled water)				Mean water stress
	S0	**S1** (1.5 gm/L of water)	**S2**(2.5 gm/L of water)	**S3**(5 gm/L of water)	
T_1	3.26	4.34	4.71	4.30	4.25
T_2	2.75	4.61	4.38	4.21	5.0
T_3	3.51	4.72	5.42	4.95	5.20
Silicate mean	3.30	4.25	5.10	4.72	5.0
L.S.D 0.05	0.31	0.15	0.62	0.37	0.53

Conclusion
The results showed a significant effect of irrigation intervals T_1 and T_2 on all traits studied, resulting in a clear tolerance of small cardamom plants to water stress and a significant increase in the total dry capsule yield. The concentrations of potassium silicate differed in their effect on the studied traits, as level S2 outperformed in its effect on the total yield and biological yield.

References

1. Nielsen RL. Drought and heat stress effects on corn pollination. J Agron. 2002;196:19-25.
2. Kaya C, Tuna L, Higgs D. Effect of silicon on plant growth and mineral nutrition of maize grown under water-stress conditions. Journal of Plant Nutrition. 2006;29(8):1469-1480.
3. Al-Shaheen MR, Soh A. Effect of proline and gibberellic acid on the qualities and qualitative traits of corn (*Zea mays* L.) under different levels of water stress. Int J Sci Res Publ. 2016;6:752-756.
4. State Planning Board. Economic review. Thiruvananthapuram (Kerala): Government of Kerala; 2016.
5. Azizi A, Hokmabadi H, Piri S, Rabiei V. Effect of kaolin application on water stress in pistachio cv. 'Ohadi'. Journal of Nut. 2013;4(4):15-20.
6. Bates LS, Waldren RPA, Teare ID. Rapid determination of free proline for water-stress studies. Plant and Soil. 1973;39(1):205-207.
7. Dong Z, Canny MJ, McCully ME, Roboredo MR, Cabadilla CF, Ortega E, Rodes R. A nitrogen-fixing endophyte of sugarcane stems: a new role for the apoplast. Plant Physiology. 1994;105(4):1139-1147.
8. Durrani FA, Subhan M, Mehmood S, Abbas S, Muhammad A, Chaudhary FY. Stimulatory effect of NAA and BAP on flowers, seeds, chlorophyll and protein content in spinach (*Spinacia oleracea* L.). Sarhad Journal of Agriculture. 2010;26(4):519-526.
9. El-Feky SS, El-Shintinawy FA, Shaker EM, Shams El-Din HA. Effect of elevated boron concentrations on growth and yield of barley (*Hordeum vulgare* L.) and alleviation of toxicity using plant growth modulators. Australian Journal of Crop Science. 2012;6(12):1687-1695.
10. Gomez KA, Gomez AA. Statistical procedures for agricultural research. New York: John Wiley & Sons; 1984.
11. Hussein MM, El-Faham SY, Alva AK. Pepper plant growth, yield, photosynthetic pigments and total phenols as affected by foliar potassium under different saline irrigation water. 2012.
12. Monjezi F, Vazin F, Hassanzadehdelouei M. Effects of iron and zinc spray on yield and yield components of wheat (*Triticum aestivum* L.) under drought stress. 2012.
13. Al-Samarrai IK, Rahi HS, Abdullah AK. Effect of water stress, hydrogen peroxide and potassium on growth and yield of maize (*Zea mays* L.). Ibn Al-Haitham Journal for Pure and Applied Science. 2013;27:39-49.
14. Addaheri AMS, Hassan OM, Khalf QS, Athab MU, Meshal OS. Potential role of cutting date in lodging and yield of three oat cultivars. IOP Conf Ser Earth Environ Sci. 2021;904(1):012021.
15. Shaban KAHA, Rashad RT, Al Kammar FAA. Efficiency of salicylic acid, gibberellic acid and silicon on corn productivity under salt-affected soil conditions.

Journal of Agricultural Science, Mansoura University. 2013;4:1021-1035.
16. Rad AHS, Malmir M, Eyni-Nargeseh H. Potassium silicate positively affects oil content, physiological and agronomic traits of *Camelina sativa* L. under optimal and drought stress conditions. Silicon. 2024;16(3):1071-1082.
17. Saudy HS, Salem EM, Abd El-Momen WR. Effect of potassium silicate and irrigation on grain nutrient uptake and water use efficiency of wheat under calcareous soils. Gesunde Pflanzen. 2023;75(3):647-654.
18. El-Sayed SF, Hassan HA, Ali AM, Gibrael AA. Effect of foliar-applied potassium silicate on growth, yield, fruit quality and antioxidant activity of tomato under deficit irrigation. International Journal of Health Sciences. 2022;6(S6):10012-10032.
19. Devi LA, Saravanan K, Desai D, Arun M, Senthilkumar N, Bremkumar S, Selvam IK. Exogenous supplementation of potassium silicate enhances growth and productivity of okra (*Abelmoschus esculentus*). Journal of Soil Science and Plant Nutrition. 2025;1-18.
20. Devi LA, Selvam IK, Nagaraj K, Arun M, Senthilkumar N, Saravanan K, Manimegalai T. Potassium silicate applications in okra (*Abelmoschus esculentus* (L.) Moench): a comprehensive review on mitigating abiotic and biotic stresses. Physiological and Molecular Plant Pathology. 2024;134:102437.
21. Xie Z, Song R, Shao H, Song F, Xu H, Lu Y. Silicon improves maize photosynthesis in saline-alkaline soils. Scientific World Journal. 2015;2015:245072.