International Journal of Advanced Biochemistry Research 2024; 8(11): 166-171

International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; 8(11): 166-171
www.biochemjournal.com
Received: 02-08-2024
Accepted: 06-09-2024

S Pradeep Kumar
Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

M Mohamed Yassin
Professor, Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Jeevan N
Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

S Marimuthu
Associate Professor, Department of Nanotechnology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

MK Kalarani
Director, Directorate of Crop Management, Department of Crop Physiology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

N Umil Singh
Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Y Sindhusree
Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Corresponding Author:
S Pradeep Kumar
Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Growth and yield responses of sweetcorn (*Zea mays* L. *saccharata*) to foliar application of nano-silica in summer season

S Pradeep Kumar, M Mohamed Yassin, Jeevan N, S Marimuthu, MK Kalarani, N Umil Singh and Y Sindhusree

DOI: https://doi.org/10.33545/26174693.2024.v8.i11c.2824

Abstract
A field experiment was carried out during the summer of 2023 at the Eastern Block Farm, Tamil Nadu Agricultural University, Coimbatore, to evaluate the effects of nano-silica foliar application on the growth and yield of sweetcorn (*Zea mays* L. *saccharata*). The experiment followed a factorial randomized block design with three replications, considering two main factors: sweetcorn growth stages and nano-silica concentrations. Control plots, with no nano-silica treatment, were included in each block for comparison. At 30 DAS, the tallest plants were recorded when nano-silica was applied at the vegetative stage (S_1) with a concentration of 500 ppm (C_5), although the height differences were not statistically significant. By 60 DAS and harvest, the tallest plants were observed when nano-silica was applied during the tassel initiation stage (S_2) compared to foliar application of nano-silica at vegetative stage (S_1) and grain filling stage (S_3). Among the varied levels of nano-silica concentrations 500 ppm, showed significant improvements. Stem girth followed a similar pattern, with the highest values at S_1 and a notable increase at 500 ppm. The average number of functional leaves was significantly higher in the tassel initiation stage (S_2), and the 500 ppm treatment outperformed other concentrations. The Leaf Area Index (LAI) was significantly greater at 60 DAS and at harvest for plants treated during S_2 with 500 ppm. Similarly, the Crop Growth Rate (CGR) was highest between 30 and 60 DAS for S_2, with 500 ppm yielding the best results, though 400 ppm (C_4) produced comparable values. Dry matter production (DMP) at harvest was also maximized in S_2, with 500 ppm proving to be the most effective concentration over 100, 200, and 300 ppm treatments. In terms of yield, the highest green cob yield was achieved with foliar application at S_2 (19.43 t ha^{-1}) and 500 ppm (20.40 t ha^{-1}), while C_4 also produced a notable yield (19.35 t ha^{-1}). Green stover yield peaked at S_2 (23.17 t ha^{-1}) and 500 ppm (23.86 t ha^{-1}). The study found that foliar application of nano-silica, particularly during the tassel initiation stage and at a concentration of 500 ppm, significantly enhanced sweetcorn growth and yield during the summer season of 2023.

Keywords: Foliar application, growth stages, nanosilica, summer, sweetcorn

Introduction
Maize has diverse uses, serving as a foundation for various products like quality protein maize (QPM), popcorn, baby corn, and sweet corn. Among these, sweet corn, also known as sugar corn, stands out due to its high sugar content and tender texture. Originating from the United States, sweet corn is characterized by its sugary endosperm and reduced starch content, resulting in its distinctive wrinkled kernels. It is highly valued for its taste and texture and is increasingly popular in both local and international markets. The crop also provides valuable by-products, such as high-quality fodder, which can be sold at premium prices, offering additional income for farmers. The quality and sweetness of sweet corn are influenced by genetic factors and optimal harvesting conditions. Sweet corn has a thinner pericarp than regular corn, contributing to its tenderness (Pradeep and Yogesh, 2005) [1]. It is typically consumed fresh, roasted, or boiled, and has optimal nutritional quality when it contains 72.7% moisture and 22.3% total solids, including 81% carbohydrates, 13% protein, and 3.5% lipid. At market maturity, sweet corn generally comprises 5-6% sugar, 10-11% starch, 3% water-soluble polysaccharides, and 70% water content (Subbaiah and Rao, 2016) [2]. It also contains significant amounts of linolenic acid and oleic acid, as well as potassium, protein, and vitamin A.

The cultivation of sweet corn is increasingly favoured by farmers due to its high market value and growing demand. Both private and public sectors have introduced hybrid varieties to meet this demand. However, the expansion of sweetcorn cultivation faces challenges, particularly in terms of available land, as it competes with other cash crops and cereals. Therefore, enhancing productivity through various management practices is essential.

Silicon (Si) content in soils ranges from 1% to 45%, but the amount of Si readily available for plant uptake is often much lower than the total Si content (Husnain & Adamy, 2012) [3]. In tropical soils, the availability of Si is particularly reduced due to the desilication process. The availability of silicon in the soil (Si-Availability) plays a crucial role in the growth of plants belonging to the Gramineae family, which are recognized as Si accumulators. For these plants, including important crops like rice, sugarcane, and maize, Si functions as a micro-essential element (Qurrohman *et al*., 2022) [4]. Research has shown that Si can support plant growth under biotic and abiotic stress by improving macronutrient uptake, leading to more efficient fertilizer use and enhanced plant productivity. Traditionally, silicon fertilizers have been applied through different methods, including soil incorporation, foliar spraying, and fertigation, using various forms of silicates (Suriyaprabha *et al*., 2014) [5] (Rana *et al*., 2023) [6]. However, continuous cropping and excessive use of nitrogen, phosphorus, and potassium fertilizers can deplete the levels of available silicon in soils (Greger *et al*., 2018) [7]. The addition of Si has been found to improve seed germination, seedling vigor, plant growth, and other physiological processes such as nitrogen fixation, photosynthesis, and root-shoot development. These improvements ultimately enhance nutrient absorption and crop yield potential. Despite its numerous benefits, silicon has historically received less attention in agricultural research compared to other essential nutrients. Recent studies, however, have demonstrated its positive effects on growth and yield in crops like rice and sugarcane (Debona *et al*., 2017) [8]. Given the significant potential of silicon to improve crop resilience and productivity, there is a growing need to explore and implement effective silica nutrition management strategies. These strategies are critical for reversing declining yield trends and maximizing crop production efficiency in modern agriculture.

Materials and Methods

A field experiment was conducted at the Eastern Block Farm, Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore, during the summer of 2023. Historical climate data for Coimbatore over the last 60 years show an average annual rainfall of 657 mm spread over 47 rainy days, with mean maximum and minimum temperatures of 31.8 °C and 22.5 °C, respectively. Relative humidity averages 85% in the morning and 52% in the afternoon, with an average solar radiation of 429 cal cm^{-2} min^{-1}, and 6.5 hours of bright sunshine per day. The trial took place from January to April 2023, during which 17.5 mm of rainfall was recorded over one rainy day. The average maximum and minimum temperatures were 33 °C and 21.2 °C, respectively, with relative humidity ranging from 80.3% in the morning to 32.9% in the afternoon. On average, there were 8.1 hours of sunshine per day.

The soil at the experimental site was sandy clay loam, slightly alkaline with a pH of 8.62, non-saline with an electrical conductivity of 0.38 dS m^{-1}, low in available nitrogen, medium in available phosphorus, and high in available potassium, with optimal levels of micronutrients and a medium organic carbon content.

Sweetcorn hybrid 'Sugar-75' was sown at a spacing of 60 cm x 20 cm. The experiment was arranged in a factorial randomized block design with three replications, incorporating two factors. The first factor was the growth stages of sweetcorn, corresponding to the application timing of rice husk-extracted nano-silica: S_1 (vegetative stage), S_2 (tassel initiation stage), and S_3 (grain filling stage). The second factor included five levels of nano-silica concentrations: C_1 (100 ppm), C_2 (200 ppm), C_3 (300 ppm), C_4 (400 ppm) and C_5 (500 ppm). Control plots with no nano-silica spray were also included in each block for comparison.

Results and Discussion

Growth parameters

Plant Height: The application of nano-silica at the vegetative stage (S_1) led to the greatest plant height at 30 DAS, with a positive correlation seen as the nano-silica concentration increased. The tallest plants were recorded with the 500 ppm treatment (C_5), although these differences were not statistically significant. At 60 DAS and at harvest, applying nano-silica during the tassel initiation stage (S_2) significantly increased plant height compared to other stages. Among the concentrations, the 500 ppm treatment (C_5) resulted in the highest plant heights at both 60 DAS and harvest, showing statistical parity with the 400 ppm treatment.

Stem Girth: The highest stem girth at 30 DAS was registered when nano-silica was applied during the vegetative stage (S_1), with significant improvements observed in the 500 ppm treatment (C_5). At 60 DAS and at harvest, significant results were obtained with the treatments involving foliar application of nano-silica at the tassel initiation stage (S_2) and the 500 ppm nano-silica concentration (C_5) with the highest stem girth recorded in sweetcorn plant.

Number of functional leaves: During summer season at harvest the number of functional leaves was found to be significant when foliar application of nano-silica was done at the tassel initiation stage and among the concentrations of nano-silica 500 ppm registered highest number of functional leaves compared to 300, 200, 100 ppm and was found to be on par with 400 ppm.

Leaf Area Index (LAI): Higher values of LAI were observed at 30 DAS, when nano-silica was applied during the vegetative stage (S_1), with an increasing trend noted in the 500 ppm treatment (C_5), although these differences were not statistically significant. Among the foliar application of nano-silica at different growth stages the highest LAI was significantly registered in the tassel initiation stage (S_2) at 60 DAS and at harvest. Among the varied levels of nano-silica concentrations, the 500 ppm treatment (C_5) exhibited the highest LAI, closely followed by the 400 ppm of nano-silica.

Crop Growth Rate (CGR): During the 30-60 DAS and from 60 DAS to harvest, application of nano-silica at the tassel initiation stage (S_2) showed the highest CGR when compared to foliar application of nano-silica at vegetative stage (S_1) and grain filling stage (S_3). Among the nano-silica concentrations, the 500 ppm treatment (C_5) registered the highest CGR, which was on par to 400 ppm only and significantly superior to rest of the treatments.

Dry Matter Production: The highest dry matter production was observed at 30 DAS, when nano-silica was applied at the vegetative stage (S_1), with an increase noted in the 500 ppm treatment (C_5), though the differences were statistically non-significant. At 60 DAS, S_2 exhibited the highest dry matter production (6292 kg ha^{-1}), with the 500 ppm treatment (C_5) being the most effective. Treatments C_3 and C_4 were found to be on par with C_5. At harvest, dry matter production was highest (12378 kg ha^{-1}) with nano-silica application during the tassel initiation stage (S_2), when compared to the application of nano-silica at the vegetative stage (S_1) and at grain filling stage (S_3). Among the nano-silica concentrations, the 500 ppm treatment (C_5) was significantly noted highest recording DMP of 12461 kg ha^{-1}, followed by the 400 ppm concentration of nano-silica (C_4), which recorded dry matter production of 12209 kg ha^{-1}.

The findings of this study align with those of Parveen *et al.* (2021), who reported a significant improvement in maize growth under abiotic stress conditions with the application of 0.8, 1.6, and 2.8 mM silicon (Si) in the form of silicic acid. Their research concluded that increased Si levels promoted growth attributes like plant height, leaf area index (LAI), chlorophyll content, specific leaf weight, and both shoot and root dry weights, which they attributed to better root moisture distribution and enhanced root penetration, particularly in maize cultivars, compared to untreated controls.

Yield parameters and yield of sweetcorn

Cob Length: The application of nano-silica at the tassel initiation stage (S_2) resulted in the longest cob length, measuring 19.35 cm. Among the nano-silica concentrations, the 500 ppm treatment (C_5) produced the longest cobs at 20.14 cm.

Cob Girth: Similar to cob length, the largest cob girth was observed with nano-silica application at the tassel initiation stage (S_2), measuring 15.05 cm. The 500 ppm treatment (C_5) also resulted in the widest cob girth (15.53).

Number of Kernel Rows per Cob: The number of kernel rows per cob registered highest with the treatment which received foliar application of nano-silica at the tassel initiation stage (S_2). Among the varied levels of nano-silica concentrations 500 ppm recorded the highest number of kernel rows per cob.

Number of Kernels per Row: Across different developmental stages, nano-silica applied at the tassel initiation stage (S_2) recorded with the highest mean count of the number of kernels per row (39.60). The 500 ppm treatment (C_5) led to the significant kernel counts per row among the concentrations with the mean count of 37.56.

Test Weight: The application of nano-silica at different developmental stages and concentrations did not show a statistically significant effect on test weight.

Green Cob Weight: Green cob weight significantly increased with nano-silica application at the tassel initiation stage (S_2), producing the heaviest cobs of 279.22 g compared to application at vegetative and grain filling stage S_1 and S_3 respectively. Among the concentrations of nano-silica, the 500 ppm treatment (C_5) resulted in the highest green cob weight (293.44).

Sweetcorn Weight: Nano-silica application at different growth stages resulted in an increase in sweetcorn weight, with the maximum weight of 231.31 g observed at the tassel initiation stage (S_2). The 500 ppm treatment (C_5) produced the highest sweetcorn weight, reaching 241.5 g.

Green Cob Yield: In the summer season of 2023, foliar application of nano-silica at the tassel initiation stage (S_2) produced the highest green cob yield, reaching 19.43 t ha^{-1}, significantly exceeding the yields from the vegetative stage (S_1) at 17.94 t ha^{-1} and the grain filling stage (S_3) at 17.29 t ha^{-1}. Among the various nano-silica concentrations, the 500 ppm treatment (C_5) resulted in the greatest yield of 20.24 t ha^{-1}, outperforming other treatments. The 400 ppm concentration (C_4) also delivered a substantial yield of 19.35 t ha^{-1} which was at par with the best treatment among the varied levels of nano-silica concentrations.

Green Stover Yield: The application of nano-silica at the tassel initiation stage (S_2) resulted in the highest green stover yield of 23.17 t ha^{-1}, significantly surpassing the yields of 21.76 t ha^{-1} at the vegetative stage (S1) and 20.51 t ha^{-1} at the grain filling stage (S_3). Among the treatments, the 500 ppm concentration (C_5) produced the maximum green stover yield of 23.86 t ha^{-1}, while the 400 ppm concentration (C_4) also demonstrated strong performance with a yield of 22.98 t ha^{-1} which was statistically found to be at par with a concentration of nano-silica at 500 ppm.

Abiotic stress in plants is caused by various factors such as salinity, drought, waterlogging, extreme temperatures, heavy metals, and UV radiation, all of which significantly reduce crop yields. The application of nanosilica to plants under stress has been shown to notably improve their morphological characteristics (Mathur and Roy, 2020) [10]. Similarly, a study by Behboudi *et al.* (2018) [11] on maize revealed that silica application can indirectly enhance crop yield by reducing shading, as it promotes more upright leaf growth. This change in leaf posture and phyllotaxy from silica fertilization has been linked to a 10-18% increase in photosynthesis. Furthermore, silica forms bio-silicified structures in the epidermal cells, which help mitigate leaf heat stress and reduce susceptibility to pests and diseases, ultimately resulting in increased green cob yields.

Table 1: Effect of varied levels of foliar application of nano-silica on plant height (cm) and stem girth (cm) at different growth stages of sweetcorn during summer 2023

Treatments	Plant height (cm)			Stem girth (cm)		
	30 DAS	60 DAS	Harvest	30 DAS	60 DAS	Harvest
S_1: Vegetative stage	41.04	141.36	169.74	2.14	6.16	7.22
S_2: Tassel initiation stage	37.39	150.06	186.07	1.93	6.40	7.59
S_3: Grain filling stage	36.88	130.84	158.31	1.93	5.83	6.87
SEd	1.80	3.76	4.17	0.04	0.13	0.16
CD (P=0.05)	NS	7.69	5.38	0.09	0.26	0.34
C_1: Foliar application of nano-silica @ 100 ppm	36.58	130.71	158.16	1.90	5.45	6.39
C_2: Foliar application of nano-silica @ 200 ppm	36.77	135.58	164.05	1.91	5.56	6.51
C_3: Foliar application of nano-silica @ 300 ppm	38.22	139.29	168.55	1.94	5.70	6.68
C_4: Foliar application of nano-silica @ 400 ppm	39.75	146.74	180.23	1.99	5.98	7.00
C_5: Foliar application of nano-silica @ 500 ppm	40.87	151.44	185.91	2.05	6.29	7.37
SEd	2.33	4.45	5.38	0.06	0.16	0.21
CD (P=0.05)	NS	9.11	11.02	0.12	0.34	0.44
SXC	NS	NS	NS	NS	NS	NS
Control: no spray	35.12	130.00	156.32	1.87	5.24	6.13

Table 2: Effect of varied levels of foliar application of nano-silica on number of functional leaves plant $^{-1}$ and leaf area index at different growth stages of sweetcorn during summer 2023

Treatments	Number of functional leaves plant $^{-1}$			Leaf area index		
	30 DAS	60 DAS	Harvest	30 DAS	60 DAS	Harvest
S_1: Vegetative stage	8.10	11.37	12.40	1.33	5.68	5.26
S_2: Tassel initiation stage	7.81	12.31	13.64	1.26	6.08	5.58
S_3: Grain filling stage	7.60	11.65	13.57	1.26	5.48	4.95
SEd	0.19	0.38	0.41	0.03	0.10	0.12
CD (P=0.05)	NS	NS	0.84	NS	0.22	0.24
C_1: Foliar application of nano-silica @ 100 ppm	7.73	11.40	12.38	1.27	4.54	4.23
C_2: Foliar application of nano-silica @ 200 ppm	7.52	11.60	12.89	1.27	4.55	4.28
C_3: Foliar application of nano-silica @ 300 ppm	7.73	11.66	12.92	1.28	4.71	4.40
C_4: Foliar application of nano-silica @ 400 ppm	8.03	11.81	13.83	1.30	4.86	4.54
C_5: Foliar application of nano-silica @ 500 ppm	8.20	12.40	14.00	1.31	5.05	4.77
SEd	0.25	0.49	0.52	0.04	0.23	0.18
CD (P=0.05)	NS	NS	1.06	NS	0.47	0.37
SXC	NS	NS	NS	NS	NS	NS
Control: no spray	7.62	11.00	12.12	1.25	4.50	4.18

Table 3: Effect of varied levels of foliar application of nano-silica on crop growth rate (g m^{-2} day^{-1}) at different growth stages of sweetcorn during summer 2023

Treatments	30-60 DAS				60 DAS-Harvest			
	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
C_1	12.91	12.61	11.85	12.46	19.13	21.70	19.05	19.96
C_2	12.81	13.50	12.17	12.83	21.02	21.24	19.24	20.50
C_3	13.19	14.57	12.40	13.39	21.15	22.60	19.80	21.18
C_4	13.45	15.44	12.93	13.94	22.98	24.98	21.63	23.20
C_5	13.66	16.16	13.00	14.27	23.33	26.11	21.77	23.73
Mean	13.20	14.46	12.47		21.52	23.33	20.30	
	S	C	SXC		S	C	SXC	
SEd	0.30	0.39	0.67		0.52	0.67	1.16	
CD (P=0.05)	0.62	0.80	NS		1.06	1.37	NS	
Control				11.75				19.12

S_1: Vegetative stage, S_2: Tassel initiation stage, S_3: Grain filling stage
C_1: Foliar application of nano-silica @ 100 ppm
C_2: Foliar application of nano-silica @ 200 ppm
C_3: Foliar application of nano-silica @ 300 ppm
C_4: Foliar application of nano-silica @ 400 ppm
C_5: Foliar application of nano-silica @ 500 ppm
Control: no spray

Table 4: Effect of varied levels of foliar application of nano-silica on dry matter production (kg ha^{-1}) at different growth stages of sweetcorn during summer 2023

Treatments	30 DAS				60 DAS				At harvest			
	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean	S_1	S_2	S_3	Mean
C_1	2149	2257	2290	2232	6231	6026	5831	6029	10994	11429	10575	10999
C_2	2244	2279	2235	2253	6262	6313	5872	6149	11497	11603	10663	11254
C_3	2351	2257	2290	2300	6293	6611	5995	6299	11560	12238	10925	11574
C_4	2528	2212	2223	2321	6385	6826	6087	6433	12107	13047	11472	12209
C_5	2634	2245	2234	2371	6461	7073	6118	6551	12270	13574	11538	12461
Mean	2381	2250	2255		6326	6570	5981		11686	12378	11035	
	S	C	SXC		S	C	SXC		S	C	SXC	
SEd	65	84	145		136	175	303		294	379	657	
CD (P=0.05)	NS	NS	NS		278	358	NS		602	777	NS	
Control				2118				5758				10607

S_1: Vegetative stage, S_2: Tassel initiation stage, S_3: Grain filling stage
C_1: Foliar application of nano-silica @ 100 ppm
C_2: Foliar application of nano-silica @ 200 ppm
C_3: Foliar application of nano-silica @ 300 ppm
C_4: Foliar application of nano-silica @ 400 ppm
C_5: Foliar application of nano-silica @ 500 ppm
Control: no spray

Table 5: Effect of varied levels of foliar application of nano-silica at different growth stages on yield attributes and yield of sweetcorn during summer 2023

Treatments	Cob length	Cob girth	No. of kernel rows cob^{-1}	No. of kernels row^{-1}	Test weight	Green cob weight (cob with husk)	Sweetcorn weight (cob without husk)	Green cob yield (t ha^{-1})	Green fodder yield (t ha^{-1})
S_1	18.17	14.33	14.24	33.86	31.05	262.26	217.14	17.94	21.76
S_2	19.35	15.05	15.07	36.11	31.85	279.22	231.31	19.43	23.17
S_3	17.13	14.09	13.98	33.13	31.36	247.29	204.84	17.29	20.51
SEd	0.43	0.26	0.28	0.70	0.76	5.96	6.18	0.44	0.58
CD (P=0.05)	0.88	0.53	0.56	1.43	NS	12.20	12.65	0.91	1.19
C_1	16.87	13.45	13.25	31.01	30.33	240.16	198.93	16.61	20.36
C_2	16.99	13.98	13.82	32.90	30.97	244.84	202.24	17.05	20.79
C_3	17.63	14.36	14.40	33.62	31.15	253.17	212.41	17.69	21.07
C_4	19.45	15.14	15.18	36.71	32.21	283.00	233.76	19.35	22.98
C_5	20.14	15.53	15.49	37.59	32.44	293.44	241.50	20.40	23.86
SEd	0.56	0.34	0.36	0.90	0.98	7.69	7.97	0.57	0.75
CD (P=0.05)	1.14	0.69	0.73	1.85	NS	15.75	16.34	1.17	1.53
SXC	NS	NS	NS	NS	NS	NS	NS	NS	NS
Control	16.22	12.98	12.64	29.84	30.00	232.05	190.59	16.10	19.56

S_1: Vegetative stage, S_2: Tassel initiation stage, S_3: Grain filling stage
C_1: Foliar application of nano-silica @ 100 ppm
C_2: Foliar application of nano-silica @ 200 ppm
C_3: Foliar application of nano-silica @ 300 ppm
C_4: Foliar application of nano-silica @ 400 ppm
C_5: Foliar application of nano-silica @ 500 ppm
Control: no spray

Conclusion

The potential for successful cultivation of sweetcorn offers a partial solution to various challenges by either expanding the area under cultivation or enhancing yield per unit area. Based on the research findings, among the growth stages the optimal growth response in sweetcorn was observed with the foliar application of nano-silica specifically at the tassel initiation stage and across varied concentrations of nano-silica a concentration of 500 ppm was found to be the prime treatment. This application demonstrated superior effectiveness compared to other growth stages and concentrations of nano-silica. The findings of this study underscore its significance, as they highlight the development of an advanced silica fertilization technique that can enhance sweetcorn production, particularly under abiotic stress conditions. This improved method may facilitate the successful cultivation of sweetcorn during the summer season, addressing the challenges associated with high-stress environments and contributing to greater resilience and productivity in sweetcorn farming.

References

1. Pradeep K, Yogesh K. Cultivation of sweet corn (*Zea mays* L. *saccharata*). Indian Farming. 2005;(10):10-12.
2. Subbaiah G, Rao CP. Yield potential, economics, and nutrient uptake of *rabi* sweet corn (*Zea mays saccharata*) as influenced by varying plant densities and nitrogen rates. International Journal of Bio-resource and Stress Management. 2016;7(2):315-319.
3. Husnain, Rochayati S, Adamy I. Nutrient management of silica in agricultural soil in Indonesia. Proceedings of the National Seminar on Fertilization Technology and Recovery of Degraded Land. 2012;(12):237-246.
4. Qurrohman BF, Taofik A, Ramadhani R, Suriadikusumah A. Effectiveness of concentration of rice husk silica extract on growth and yield of sweet

corn (*Zea mays saccharata* Strut). Bulgarian Journal of Agricultural Science. 2022;28(1):61-68.
5. Suriyaprabha R, Karunakaran G, Kavitha K, Yuvakkumar R, Rajendran V, Kannan N. Application of silica nanoparticles in maize to enhance fungal resistance. IET Nanobiotechnology. 2014;8(3):133-137.
6. Rana S, Zia ur Rehman M, Umair M, Ayub MA, Arif M. Silicon-mediated alleviation of heavy metal stress in plants. Beneficial Chemical Elements of Plants: Recent Developments and Future Prospects. 2023;8:256-276.
7. Greger M, Landberg T, Vaculík M. Silicon influences soil availability and accumulation of mineral nutrients in various plant species. Plants. 2018;7(2):41.
8. Debona D, Rodrigues FA, Datnoff LE. Silicon's role in abiotic and biotic plant stresses. Annual Review of Phytopathology. 2017;55(1):85-107.
9. Parveen A, Ahmar S, Kamran M, Malik Z, Ali A, Riaz M, Abbasi GH, Khan M, Sohail AB, Rizwan M, Afzal S. Abscisic acid signaling reduced transpiration flow, regulated Na^+ ion homeostasis, and antioxidant enzyme activities to induce salinity tolerance in wheat (*Triticum aestivum* L.) seedlings. Environmental Technology & Innovation. 2021;24:101808.
10. Mathur P, Roy S. Nanosilica facilitates silica uptake, growth, and stress tolerance in plants. Plant Physiology and Biochemistry. 2020;157:114-127.
11. Behboudi F, Sarvestani TZ, Kassaee MZ, Modares Sanavi SA, Sorooshzadeh A. Improving growth and yield of wheat under drought stress via application of SiO_2 nanoparticles. Journal of Agricultural Science and Technology. 2018;20(7):1479-1492.