International Journal of Advanced Biochemistry Research

ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2025): 5.29
IJABR 2025; SP-9(10): 1036-1039
www.biochemjournal.com
Received: 15-07-2025
Accepted: 17-08-2025

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Diatomaceous earth as a source of silicon in tomato (*Solanum lycopersicum* L.)

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DOI: https://www.doi.org/10.33545/26174693.2025.v9.i10Sm.5983

Abstract
Tomato (*Solanum lycopersicum* L.) is one of the most important vegetable crops in India, with increasing demand for sustainable production practices. Silicon has been recognized as a beneficial element that enhances plant growth, stress tolerance, and yield, yet it is often not in available form in soils. Diatomaceous earth (DE), a natural source of amorphous silica, was evaluated as a source of silicon amendment in tomato cultivation. Field experiments were conducted at RHREC, Hiriyur, Karnataka, using the variety *Arka Ananya* in a randomized complete block design (RCBD) with nine treatments. Treatments consisted of the recommended package of practices (POP), 50% POP, and their combinations with DE at 250, 500, and 750 kg/ha, along with a DE-alone treatment. Growth attributes, yield, silica uptake, and economics were assessed. Results revealed that the application of POP + DE (750 kg/ha) significantly improved leaf number, branching, and yield (65.73 t/ha), while in the second treatment POP + DE (500 kg/ha) recorded the highest yield (63.29 t/ha). Half POP + DE treatments also enhanced yield compared to 50% POP alone, indicating a potential reduction in fertilizer use without compromising productivity. Economic analysis showed maximum net returns in POP + DE (750 kg/ha and 500 kg/ha in). These findings suggest that DE is an effective silicon source, improving tomato performance and offering a sustainable approach to fertilizer management.

Keywords: Tomato, diatomaceous earth, silicon, yield, sustainable agriculture, economics

Introduction
Tomato (*Solanum lycopersicum* L.) occupies a prominent position among vegetable crops in India due to its high economic value and consumer demand. India ranks second globally in tomato cultivation, with a production of 16.34 million tonnes, after China. Andhra Pradesh and Karnataka are among the leading tomato-producing states. With the growing population, despite limited scope for expansion in cultivated area. Enhancing productivity through efficient input use is critical.

Among the nutrients, silicon (Si) is increasingly recognized as a beneficial element that plays a significant role in plant growth, yield improvement, and tolerance to biotic and abiotic stresses. Although not considered essential, silicon supplementation has been reported to enhance structural strength, photosynthetic efficiency, and disease resistance in crops. Tomato, despite being a non-accumulator, can respond positively to external silicon sources.

Diatomaceous earth (DE) is a naturally occurring siliceous material derived from fossilized diatoms. It is rich in amorphous silica and has been explored as a soil amendment to improve nutrient availability, plant growth, and stress tolerance. However, limited research has been carried out on its role in vegetable crops, particularly tomato. The present study was undertaken to evaluate the effect of diatomaceous earth as a source of silicon on growth, yield, silica uptake, and economics of tomato under field conditions.

Materials and Methods
Field experiment was conducted at the College of Horticulture (COH), Hiriyur, Karnataka, under sandy loam soil conditions. Initial soil parameters included slightly alkaline pH (7.68), medium available nitrogen (258-266 kg/ha), and adequate potassium (338 kg/ha), with low organic carbon content (0.48%).

Table 1: Initial soil parameters of the experimental site

Assessment	
pH	7.68
EC	1.12 dS/m
Av N	266 kg/ha
Olson-p	26.8 kg/ha
Av K	338 kg/ha
Ex. Na	9 me/100 g
Zn (DTPA)	0.61 ppm
Mn(DTPA)	8.23 ppm
Copper (DTPA),	2.05 ppm
Iron (DTPA)	10.55 ppm
B	0.62 ppm
S	11.35 ppm
Organic carbon	0.48 %
CEC	12 me/100 g

Tomato variety Arka Ananya was used. The experiment was laid out in a randomized complete block design (RCBD) with three replications and nine treatments were evaluated, the details of the cultivation practices presented in table 2,

Table 2: Details of Tomato Experiment carried out at COH, Hiriyur

Location	RHREC, Hiriyur
Crop	Tomato
Variety	Arka Ananya
Design	RCBD
Replication	Three
Treatments	Nine
Individual plot size	5.4 x4.5 m
Plant Spacing	90 x 45 cm
Fertilizer rate and schedule	RDF 250:250:250 NPK/ha
Pestcide application pest	Sucking and fruit borar
Disease	Leaves spot
Weeds	3 times
Irrigation type	Furrow method
POP followed	FYM @ 38 t/ha
DE application method and timing	Ring method @ transplanting
Soil texture	Sandy Loamy soil

Treatments included absolute control, 100% POP (recommended package of practices), 50% POP, POP + DE at 250, 500, and 750 kg/ha, 50% POP + DE at 250, 500, and 750 kg/ha, and DE alone at 500 kg/ha. Fertilizer sources included urea, DAP, and MOP. Diatomaceous earth was applied at transplanting by ring method. Standard crop management practices (irrigation, pest and weed control) were followed. The detailed treatments were depicted below

Treatment Details

T_1: Control (Absolute)
T_2: Package of practice (POP)
T_3: ½ POP
T_4: POP + DE @ 250 kg ha^{-1}
T_5: POP + DE @ 500 kg ha^{-1}
T_6: POP + DE @ 750 kg ha^{-1}
T_7: ½ POP + DE @ 250 kg ha^{-1}
T_8: ½ POP + DE @ 500 kg ha^{-1}
T_9: ½ POP + DE @ 750 kg ha^{-1}

Observations recorded included growth attributes (plant height, leaves, branches, fruits), yield (kg/plot, t/ha), silica uptake (leaf and fruit), and economics (cost of cultivation, gross and net returns). Data were analyzed using ANOVA at 5% level of significance.

Results and Discussion

Growth attributes were significantly influenced by DE application, POP + DE @ 750 kg/ha (T_6) significantly increased leaf number and branching over POP alone, POP + DE @ 500 kg/ha (T_5) recorded the highest number of leaves, fruits, and branches. Half POP + DE treatments also improved growth compared to half POP alone, indicating DE supplementation compensated for reduced fertilizer input. Plant height was not significantly influenced by DE (table 3)

Table 3: Effect of silica on growth and yield of Tomato

Treatment	Plant Height	Leaves	Branches	Yield (Kg/plot)	Yield (Ton/ha)
T_1	60.81	12.50	3.53	96.41	39.67
T_2	65.48	19.57	5.19	138.06	56.81
T_3	63.20	17.83	4.50	122.10	50.25
T_4	65.39	22.53	5.07	143.56	59.08
T_5	65.53	22.83	5.17	154.82	63.71
T_6	63.29	23.33	5.27	157.39	65.73
T_7	62.70	18.30	5.10	133.45	54.92
T_8	63.21	22.37	5.07	151.14	62.20
T_9	63.19	22.33	5.20	154.06	63.40
CD @ 5%	NS	5.40	1.30	18.15	11.85
CV	6.06	15.48	15.44	7.54	11.94
S. Em ±	11.13	1.80	0.43	6.05	3.95

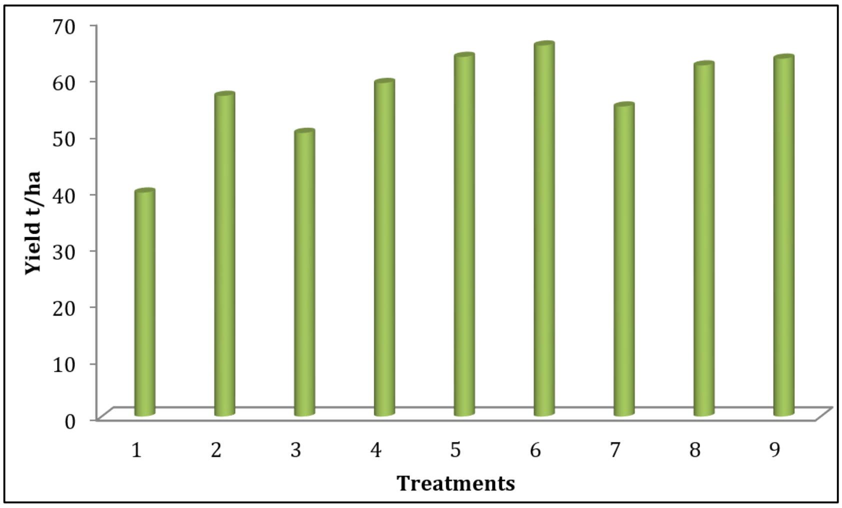

Fig 1. Effect of silica on yield of Tomato

Tomato yield responded positively to DE application, POP + DE @ 750 kg/ha produced the highest yield (65.73 t/ha), while POP + DE @ 500 kg/ha produced the maximum yield (63.29 t/ha). Half POP + DE treatments also achieved higher yields than half POP alone, while DE alone at 500 kg/ha produced lower yield compared to other treatments. Economic analysis indicated maximum net returns in POP + DE @ 750 kg/ha and POP + DE @ 500 kg/ha. Half POP + DE treatments also yielded favorable returns compared to POP alone, demonstrating DE application can reduce fertilizer costs while maintaining profitability (table 4)

Table 4: Economics of Tomato cultivation at COH-Hiriyur

Treatments	Input fertilizer				FYM	Other cost	Total cost	Gross yield t/ha	Gross return Rs/ha	Net returns
	N (Rs/kg)	P (Rs/kg)	K (Rs/kg)	Total cost (NPK)						
T_1	-	-	-	-	-	66950	66950	39.68	198400	131450
T_2	1753	9783	6914	18450	15200	68450	102100	56.81	284050	181950
T_3	877	4892	3457	9226	15200	68450	92876	50.24	251200	158324
T_4	1753	9783	6914	18450	15200	68450	102100	59.08	295400	193300
T_5	1753	9783	6914	18450	15200	68450	102100	63.71	318550	216450
T_6	1753	9783	6914	18450	15200	68450	102100	67.77	338850	236750
T_7	877	4892	3457	9226	15200	68450	92876	54.92	274600	181724
T_8	877	4892	3457	9226	15200	68450	92876	62.20	311000	218124
T_9	877	4892	3457	9226	15200	68450	92876	63.40	317000	224124

DAP-18 Rs/kg, MOP-Rs16.58/kg Urea-Rs 5.3/kg, FYM-Rs 4/kg, Tomato-Rs 5.0/kg

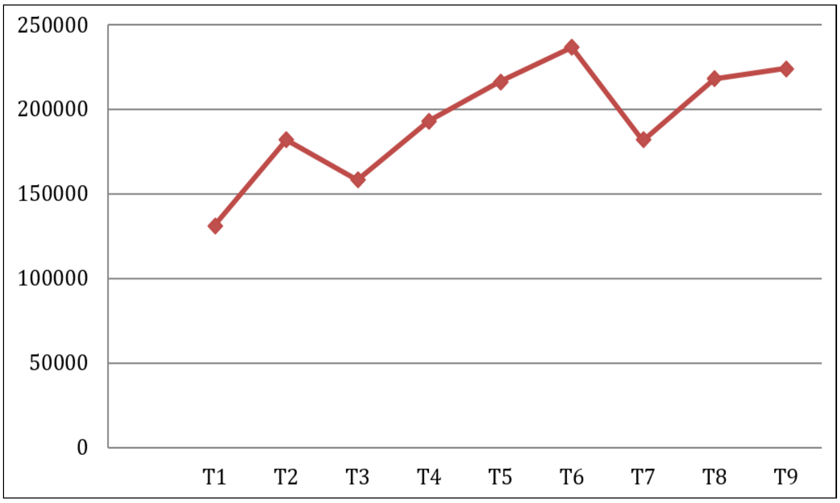

Fig 2. Net returns in Rs. per hectare

The data presented in Table 4 indicated that tomato fruit yield of Arka Ananya was significantly influenced by an application of DE as a source of silicon. Among the different levels of DE with POP, application of T_6: POP + DE @ 750 kg/ha gave significantly higher economic returns over rest of the POP treatments and was at par with the treatments of POP+DE (500). In case of treatment, ½ POP + DE @ 750 kg/ha also significantly increased the tomato economic returns over POP (T_2) which reduced 50% of POP which will help in cost reduction in terms of chemical fertilizer and soil pollution too and get higher economic return.

The positive effects of DE application may be attributed to improved nutrient availability, enhanced photosynthetic efficiency, and stress mitigation due to silicon deposition in plant tissues. These results highlight DE as a cost-effective alternative for sustainable tomato cultivation, particularly when combined with reduced chemical fertilizer use.

Conclusion

Diatomaceous earth proved to be an effective silicon source in tomato cultivation. Application of DE along with POP significantly improved growth, yield, and economic returns of tomato over POP alone. While POP + DE @ 750 kg/ha performed best, followed by POP + DE @ 500 kg/ha was superior. Half POP + DE treatments were also effective, offering opportunities for beneficial effect of silica in reducing chemical fertilizer use without compromising productivity. Thus, DE application can be recommended as a sustainable practice to enhance tomato productivity and profitability.

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