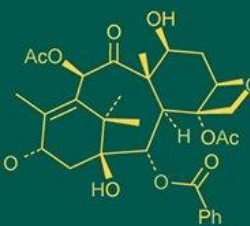
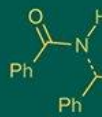


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; SP-10(9): 474-477
www.biochemjournal.com
Received: 22-07-2026
Accepted: 27-08-2026

VP Singh
Kittur Rani Channamma
College of Horticulture,
University of Horticultural
Sciences, Bagalkot,
Karnataka, India

Mohammed Farooq
College of Horticulture,
University of Horticultural
Sciences, Bagalkot,
Karnataka, India

Anand G Patil
Directorate of Education,
University of Horticultural
Sciences, Bagalkot, Karnataka,
India

SV Patil
College of Horticulture,
University of Horticultural
Sciences, Bagalkot,
Karnataka, India

Vijaymahantesh
College of Horticulture,
University of Horticultural
Sciences, Bagalkot,
Karnataka, India

Jyoti Uppar
Kittur Rani Channamma
College of Horticulture,
University of Horticultural
Sciences, Bagalkot,
Karnataka, India

Shanigala Raviteja
College of Horticulture,
Bagalkot, Karnataka, India

Corresponding Author:
VP Singh
Kittur Rani Channamma
College of Horticulture,
University of Horticultural
Sciences, Bagalkot,
Karnataka, India

Response of stevia (*Stevia rebaudiana* Bertoni) to different plant geometry regimes for growth, and herbage yield under North-Eastern transitional zone of Karnataka

VP Singh, Mohammed Farooq, Anand G Patil, SV Patil, Vijaymahantesh, Jyoti Uppar and Shanigala Raviteja

DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i9Sf.9871>

Abstract

Stevia rebaudiana, a perennial herb valued for its steviol glycosides, has emerged as a promising natural sweetener. Despite, an annual requirement of stevia is about 10 metric tons in India, the impact of agronomic practices in stevia cultivation remains poorly explored. The major objective of the study was to determine the effect of spacing on growth parameters of stevia (*Stevia rebaudiana* Bertoni.) under the North-Eastern transitional zone of Karnataka. The field experiment was conducted during 2020-21 and 2021-22 at the College of Horticulture, Bidar, University of Horticultural Sciences, Bagalkot, Karnataka. The study was laid out in Randomized Block Design (RBD) with three replications and nine spacing treatments such as T₁ with a spacing of 30x10 cm, T₂-30x20 cm, T₃-30x30 cm, T₄-45x10 cm, T₅-45x20 cm, T₆-45x30 cm, T₇-60x10 cm, T₈-60x20 cm and T₉-60x30 cm. Growth parameters such as plant height, number of leaves per plant, number of branches per plant and chlorophyll content (mg/g) were recorded at different growth stages of stevia and results revealed that wider spacing significantly improved the growth parameters and chlorophyll content in stevia. Treatment T₉ (60 × 30 cm) recorded maximum plant height (44.12 cm), number of leaves per plant (324.03), number of branches per plant (24.32) and chlorophyll content (0.3240 mg/g). However, T₁ (30 × 10 cm) recorded the minimum values for all growth parameters. The study was concluded that spacing of T₉(60 × 30 cm) was found superior for better growth and chlorophyll content in stevia cultivation and T₂(30×20 cm) recorded maximum fresh (8.69 t) and dry herbage (1.81 t) yield per hectare.

Keywords: Stevia, spacing, growth, chlorophyll, herbage, yield

Introduction

Meethi tulsi (*Stevia rebaudiana* Bertoni.) belongs to the family Asteraceae, is an important medicinal plant known for its anti-diabetic properties (Wang *et al.*, 2025) [21]. Different classes of diterpene glycosides are present in stevia leaves (Stevioside and Rebaudisides) which are non-nutritive, nontoxic, antioxidant, antifungal, antimicrobial, anticarcinogenic high potency sweeteners and may substitute sucrose as well as other synthetic sweeteners, being 300 times sweeter than sucrose (Amala *et al.*, 2026) [3]. In India around 50 million people are suffering from type-2 diabetes. Stevioside has medicinal properties which helps in curing diabetes, tooth ache and tooth decay, while the sweetening property of stevia is due to rebaudiside (Goyal *et al.*, 2010) [7]. Stevia cultivation covers 32,000 hectares worldwide, with China accounting for 75 percent of the total area. Currently, stevia is widely used in Japan. Due to the huge demand for diabetic products in the market, Indian farmers have also started growing stevia. Stevia is now being grown by farmers in several areas of Rajasthan, Punjab, Uttar Pradesh, West Bengal, Madhya Pradesh, Andhra Pradesh, Karnataka, Chhattisgarh and other Indian states (Chughtai *et al.*, 2020) [4]. Stevia usage is gaining momentum because of its novel anti-diabetic activity and also showed effect against inflammation as well as bacteria (Sardana *et al.*, 2025) [15]. In the market many drugs which contain *S. rebaudiana* have been released under brand name like 'Sweet leaf' against diabetic disorders, high blood pressure and general debility (Schiatti *et al.*, 2025) [16]. It is also known as sweet treat, honey leaf, sweet herb and candy leaf (Peteliuk *et al.*, 2021) [12].

Because of its numerous medicinal properties, the plant is in great demand from both *ayurvedic* and pharmaceutical industries (Yadav *et al.*, 2011) [22]. Other than medicinal uses stevia products and extracts are now used in a variety of food products. The steviol glycosides obtained from stevia leaves are used as an alternative to sugars in variety of foods and beverages. It is used as table sugar, in soft drinks, pastry, pickles, tobacco products, candy, jam, yoghurt, chewing gum, sorbets *etc.* (Kumari *et al.*, 2020) [9]. Stevia is a new and emerging crop and very rare information is available on the crop geometry and the quality control in Indian condition. Plant spacing is an important non-monetary agronomical practice that determines the spatial arrangements of plants that influence canopy structure, light interception and radiation use efficiency and ultimately, biomass production of crops. As stevia achieved economic importance due to different natural steviol glycosides, obtained from its leaves which are many times sweeter than cane sugar and sugar beet. Therefore, in view of the above, the present investigation was undertaken to find out planting density of stevia is an important tool in order to achieve high crop yield, quality, suitable adaptation and mitigation strategies able to encourage sustainable development to the farmers under North-Eastern transitional zone of Karnataka.

Materials and Methods

The study was carried out during 2020-21 and 2021-22 at College of Horticulture, Bidar, University of Horticultural Sciences, Bagalkot, Karnataka. The experimental site is located at 17.92° N latitude, 77.52° E longitude and 670 m altitude above the mean sea level (MSL) and received the annual rain fall of 872.4 mm for the year 2020-2021 and 1120.8 mm for 2021-2022 with maximum average temperature was recorded in the month of May (39 °C) and April (36.8 °C), respectively. The minimum average temperature was noticed during December and the highest average relative humidity in the morning was recorded in August (87%) and September (89%) in the year 2020-2021 and 2021-2022 respectively. Randomized Block Design (RBD) was used to laid out in experiment with three replications and nine treatments: T₁-30x10 cm, T₂-30x20 cm, T₃-30x30 cm, T₄-45x10 cm, T₅-45x20 cm, T₆-45x30 cm, T₇-60x10 cm, T₈-60x20 cm and T₉-60x30 cm. Variety GKVK stevia-1 was used for experiment, while one month old seedlings were for transplanting as per designs in their respective plots with the plot size of 1.80 x 2.40 m. The recommended dose of fertilizers were applied during the crop growth and gap filling was done 20 days after transplanting (DAT) in order to maintain the ideal plant population per plot. Weeds were controlled through hand

weeding whenever necessary, while irrigation was given at 5-7 day intervals as per requirement and plant protection measures were followed. In this study, five plants/plot were randomly chosen for recording growth and yield characters such as plant height (cm), number of branches/plant, number of leaf/plant at 30, 60 and 90 DAT, while chlorophyll content (mg/g) at 60 DAT, which was estimated through the DMSO (Dimethyl Sulfoxide) from stevia leaves at peak growth stage. The experimental results were analysed statistically by Analysis of Variance (ANOVA) for Randomized Block Design (RBD) as per Gomez and Gomez (1984) [6]. F-test was employed to determine significance of treatment differences and treatment means were compared using Critical Difference (CD) at 5 percent level of significance.

Results and Discussion

1. Plant height (cm)

Results of this experiment have proved a significant ($p < 0.05$) impact of various spacing of stevia plants on their growth in terms of plant height. Data was recorded at an interval of 30, 60 and 90 DAT (Table 1). The plant height was increased significantly ($p < 0.05$) with increasing of spacing. With respect to treatments, at 30 DAT significantly maximum plant height was noticed in T₉ (60x30 cm) with plant height of 22.63 cm (pooled), where T₁ (30x10 cm) showed the minimum plant height (14.87 cm). At 60 DAT, significantly maximum plant height (33.83 cm) was observed in T₈ (60x20 cm), whereas the minimum plant height 20.77 cm) was recorded from T₁ (30x10 cm). However, T₇ (60x10 cm), was found to be statistically on par to T₈ (60x20 cm) spacing at 60 DAT. The pooled plant height (44.12 cm) at 90 DAT was noted maximum from T₉ (60x30 cm) and minimum plant height (31.79 cm) was observed from T₁ (30x10 cm) whereas, T₈ (60x20 cm) was on par with T₉ (60x30 cm). The reason for increase in plant height may be due to the wider spacing result in less inter-plant competition confirmed by findings of Dheer *et al.* (2025) [5], Taleie *et al.* (2012) [20] and Shivani *et al.* (2019) [17]. Plant height was not significantly influenced by spacing levels. Similar observations were reported by Sniegowska and Biesiada (2024) [18], who found comparable plant heights under 50x30 cm, 45x25 cm and 30x30 cm spacing. In contrast Junaidath *et al.* (2022) [8] reported that plant height was increased with decrease in spacing, where the tallest plants (38.89 cm) were recorded under 15x10 cm spacing, and the shortest plants (34.73 cm) were observed under 15x15 cm spacing at flower bud initiation, indicating that closer spacing promoted stem elongation due to competition for light.

Table 1: Effect of spacing on plant height (cm) at different growth stages in stevia

Treatment	Plant height (cm)								
	30 DAT			60 DAT			90 DAT (At harvest)		
	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
T ₁ (30X10 cm)	15.25	14.49	14.87	21.30	20.24	20.77	32.60	30.97	31.79
T ₂ (30X20 cm)	17.10	16.25	16.67	23.30	22.14	22.72	34.85	33.11	33.98
T ₃ (30X30 cm)	18.90	17.96	18.43	29.26	27.80	28.53	37.95	36.05	37.00
T ₄ (45X10 cm)	18.30	17.39	17.84	27.40	26.03	26.72	36.88	35.04	35.96
T ₅ (45X20 cm)	17.80	16.91	17.36	22.87	21.72	22.30	35.18	33.42	34.30
T ₆ (45X30 cm)	19.65	18.67	19.16	30.15	28.64	29.40	40.30	38.29	39.29
T ₇ (60X10 cm)	22.15	21.04	21.60	33.55	31.87	32.71	42.45	40.33	41.39
T ₈ (60X20 cm)	22.60	21.47	22.04	34.70	32.97	33.83	43.15	40.99	42.07
T ₉ (60X30 cm)	23.21	22.05	22.63	35.64	25.70	30.67	45.25	42.99	44.12
S Em.±	1.45	1.30	1.36	1.67	2.14	1.79	2.30	2.14	2.22
C.D. at 5%	4.36	3.91	4.10	5.01	6.42	5.39	6.92	6.43	6.67

2. Total chlorophyll content (mg/g)

Chlorophyll, a key photosynthetic pigment that absorbs light energy and converts it into chemical energy, during photosynthesis, thus making it essential for plant growth and development. From this experiment, the total chlorophyll content (chlorophyll a + b) estimation was recorded at peak growth stage of stevia at 60 DAT is presented in Table 2. The chlorophyll content was increased significantly ($p < 0.05$) with increasing of spacing, where the pooled data of T₉ (60x30 cm) showed the maximum chlorophyll content (0.324 mg/g) and T₁ (30x10 cm) revealed the minimum chlorophyll content (0.218 mg/g), whereas T₈ (60x20 cm) with chlorophyll content 0.313 mg/g was on par with T₉

(60x30 cm) among all treatments. The results clearly indicated that lower plant density at (60x30 cm) spacing performed better in terms of chlorophyll content, due to the adequate availability of sunlight. Kumari *et al.* (2021) [10] studied the effect of spacing on amount of chlorophyll present in the stevia leaves was found to be non-significant. In broccoli, wider spacing (60x45 cm) significantly increased chlorophyll content (77.29 SPAD units), indicating improved photosynthetic efficiency due to better canopy exposure and reduced shading. The results were confirmed by Santhosh *et al.* (2019) [14] and Abhijithnaik *et al.*, (2022) [1].

Table 2: Effect of spacing on total chlorophyll content (mg/g) of stevia at 60 DAT

Treatment	Chlorophyll content (mg/g)		
	2020-21	2021-22	Pooled
T ₁ : 30X10 cm	0.226	0.210	0.218
T ₂ : 30X20 cm	0.235	0.218	0.226
T ₃ : 30X30 cm	0.282	0.263	0.273
T ₄ : 45X10 cm	0.275	0.256	0.266
T ₅ : 45X20 cm	0.260	0.242	0.251
T ₆ : 45X30 cm	0.294	0.273	0.284
T ₇ : 60X10 cm	0.316	0.293	0.304
T ₈ : 60X20 cm	0.325	0.302	0.313
T ₉ : 60X30 cm	0.336	0.312	0.324
S Em.±	0.016	0.016	0.016

3. Fresh and dry herb yield per hectare (t) The pooled results for the period 2020-2022 revealed that T₂(30 × 20 cm) recorded the highest herb production, with 8.69 t ha⁻¹ fresh yield and 1.81 t ha⁻¹ dry yield. Conversely, T₉ (60 × 30 cm) recorded in the lowest fresh and dry herb yields of 3.39 t ha⁻¹ and 0.70 t ha⁻¹, respectively (Table3). An increase in spacing reduced the plant population, thereby lowering the fresh and

dry herb yield per hectare. This experiment observed that closer spacing recorded the highest fresh biomass yield and wider spacing observed with minimum fresh and dry herb yield per hectare due to fewer plant population. Similar results were observed by Aladakatti *et al.* (2012) [2], Rashid *et al.* (2015) [13], Sniegowska and Biesiada (2024) [18] and Tadesse *et al.* (2016) [19].

Table 3: Effect of spacing on fresh and dry herbage yield per hectare (t)

Treatment	Fresh weight per hectare (t)			Dry weight per hectare(t)		
	2020-21	2021-22	Pooled	2021	2022	Pooled
T ₁ (30X10 cm)	6.86	6.38	6.62	1.43	1.33	1.38
T ₂ (30X20 cm)	9.00	8.37	8.69	1.88	1.74	1.81
T ₃ (30X30 cm)	8.82	8.20	8.51	1.84	1.71	1.77
T ₄ (45X10 cm)	7.93	7.38	7.66	1.65	1.54	1.59
T ₅ (45X20 cm)	7.89	7.33	7.61	1.64	1.53	1.59
T ₆ (45X30 cm)	6.67	6.21	6.44	1.39	1.29	1.34
T ₇ (60X10 cm)	4.20	3.91	4.05	0.88	0.81	0.84
T ₈ (60X20 cm)	3.92	3.65	3.78	0.82	0.76	0.79
T ₉ (60X30 cm)	3.50	3.26	3.38	0.73	0.68	0.70
SEm.±	0.62	0.57	0.59	0.12	0.12	0.12
C.D.at5%	1.86	1.73	1.79	0.38	0.36	0.37

Conclusion

The findings of the experiment proved that, among the different spacing treatments, the widest spacing *i.e.* T₉ (60x30 cm), significantly showed better performance with respect to growth factors. It consistently recorded higher plant height as well as chlorophyll content of stevia leaves, which was increasing significantly with increasing of spacing. However, closer spacing T₂ (30x20 cm) recorded maximum fresh and dry herbage yield per hectare.

References

1. Abhijithnaik S, Srinivasappa KN, Hanumantharaya BG, Gayen R, Budensha B, Vijaykumar BT, *et al.* Effect of spacing and nutrient on growth of broccoli (*Brassica oleracea* var. *italica*) under open field condition. The Pharma Innovation Journal. 2022;11(11):1489-1493.
2. Aladakatti YR, Palled YB, Chetti MB, Halikatti SI, Alagundagi SC, Patil PL, *et al.* Effect of irrigation schedule and planting geometry on growth and yield of stevia (*Stevia rebaudiana* Bertoni). Karnataka Journal of Agricultural Sciences. 2012;25(1):24-30.
3. Amala B, Sugunya Y, Swaroopa P, Dasharadha RR. *Stevia rebaudiana* as a functional natural sweetener in diabetes management: health implications and food industry applications: a critical review. International Journal of Advanced Biochemistry Research. 2026;10(3):591-598.

4. Chughtai MFJ, Pasha I, Zahoor T, Khaliq A, Ahsan S, Wu Z, *et al.* Nutritional and therapeutic perspectives of *Stevia rebaudiana* as emerging sweetener; a way forward for sweetener industry. *Journal of Food Science*. 2020;18(1):164-177.
5. Dheer A, Hari OS, Pramod KT, Akanksha J, Anil KY. Evaluation of growth, yield and economics of *Stevia rebaudiana* Bertoni under partial shade in a teak-based agroforestry system in the sub-tropical region of Madhya Pradesh. *Plant Science Today*. 2025;12(1):1-12.
6. Gomez KA, Gomez AA. *Statistical Procedures for Agricultural Research*. 2nd ed. New York: John Wiley and Sons; 1984. p.134-138.
7. Goyal SK, Samsher N, Goyal R. *Stevia (Stevia rebaudiana B.) a bio-sweetener: a review*. *International Journal of Food Sciences and Nutrition*. 2010;61(1):1-10.
8. Junaidath P, Sindhu PV, Prameela P, Beena C, Menon SS. Growth and yield of stevia (*Stevia rebaudiana* Bertoni) as influenced by plant density and pinching. *International Journal of Plant & Soil Science*. 2022;34(24):447-455.
9. Kumari S, Ghosh G, Mesharm MK. Total soluble solids, yield, nutrient uptake and energetics of stevia (*Stevia rebaudiana* B.) as influenced by nitrogen levels and spacing under Eastern UP conditions. *Current Advances in Agricultural Sciences*. 2020;12(2):117-120.
10. Kumari S, Ghosh G, Meshram MR. TSS, yield and energetics of stevia as influenced by nitrogen levels and spacing under Eastern UP conditions. *Agricultural Science Digest*. 2021;41(2):319-323.
11. Naruka IS, Singh PP, Barde M, Rathore SS. Effect of spacing and nitrogen levels on growth, yield and quality of ajwain (*Trachyspermum ammi* L. Sprague). *International Journal of Seed Spices*. 2012;2(1):12-17.
12. Peteliuk V, Rybchuk L, Bayliak M, Storey KB, Lushchak O. Natural sweetener *Stevia rebaudiana*: functionalities, health benefits and potential risks. *EXCLI Journal*. 2021;20:1412-1430.
13. Rashid Z, Inamullah S, Peer QJA, Rashid M, Souliha R. Influence of crop geometry on yield, yield attributes and glycoside yield of *Stevia rebaudiana* Bertoni. *Journal of Applied and Natural Science*. 2015;7(1):339-344.
14. Santhosh B, Thatikunta R, Reddy DVV, Hussain SA, Gouri Shankar V. Physiological basis of improved yields in rainfed cotton under high density planting system. *Indian Journal of Plant Physiology*. 2019;24(3):412-419.
15. Sardana P, Lone AF, Kaundal M. *Stevia rebaudiana*: nature's zero calorie sustainable sweetener. *International Journal of Research in Agronomy*. 2025;8(11):398-405.
16. Schiatti SIP, Quintana SE, Garcia-Zapateiro LA. *Stevia (Stevia rebaudiana)* as a common sugar substitute and its application in food matrices: an updated review. *Journal of Food Science and Technology*. 2023;60(5):1483-1492.
17. Shivani K, Gautam G, Sukany G, Mesharm MR. Impact of spacing and levels of nitrogen on growth and yield of stevia (*Stevia rebaudiana* Bertoni). *Journal of Pharmacognosy and Phytochemistry*. 2019;8(3):1878-1881.
18. Sniegowska J, Biesiada A. Effect of spacing on growth, yield and chemical composition of stevia plants (*Stevia rebaudiana* Bert.). *Applied Sciences*. 2024;14(12):5153.
19. Tadesse N, Gebere A, Lulie B, Hordofa M. Influence of plant population density on growth and yield of stevia (*Stevia rebaudiana* Bertoni L.) at Wondo Genet South Ethiopia. *Academic Research Journal of Agricultural Science and Research*. 2016;4(6):321-329.
20. Taleie N, Hamidoghli Y, Rabiei B, Hamidoghli S. Effects of plant density and transplanting date on herbage, stevioside, phenol and flavonoid yield of *Stevia rebaudiana* Bertoni. *International Journal of Agriculture and Crop Sciences*. 2012;4(6):298-302.
21. Wang L, Chang T, Zhu T, Hu W, Wang X, Dong C, *et al.* *Stevia rebaudiana* Bertoni as a sweet herbal medicine: traditional uses, potential applications and future development. *Frontiers in Pharmacology*. 2025;16:1638147.
22. Yadav AK, Singh S, Dhyani D, Ahuja PS. A review on the improvement of stevia [*Stevia rebaudiana* (Bertoni)]. *Canadian Journal of Plant Science*. 2011;91(1):1-27.