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INFLUENCE OF INTEGRATED NUTRIENT MANAGEMENT ON GROWTH ATTRIBUTES OF STEVIA (*Stevia rebaudiana* BERTONI) UNDER NORTH-EAST TRANSITIONAL CONDITIONS OF KARNATAKA INDIA

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ABSTRACT

A field experiment was conducted during 2025-26 at a farmer's field in the vicinity of College of Horticulture, Bidar, University of Horticultural Sciences, Bagalkot, situated in the North-Eastern transitional zone (Zone-I) of Karnataka, to study the effect of primary nutrients (NPK), boron and Jeevamrutha on growth parameters of stevia (*Stevia rebaudiana* Bertoni). The experiment was laid out in a randomized complete block design comprising 13 treatments combinations of three levels of recommended dose of fertilizers (50, 75 and 100% RDF), two levels of foliar boron (0.25 and 0.5%) with and without 5 per cent Jeevamrutha, along with a control (100% RDF alone), replicated thrice. Plant height, number of branches per plant, number of leaves per plant and plant spread were recorded at 30, 60 and 90 days after planting (DAP). Application of 100 per cent RDF along with 0.5 per cent boron and 5 per cent Jeevamrutha (T_{12}) recorded the maximum plant height (44.11 cm), number of branches per plant (42.10), number of leaves per plant (441.51) and plant spread (192.68 cm^2) at 90 DAP. The lowest values of all four growth parameters were recorded under 50 per cent RDF + 0.25 per cent boron (T_1). Based on the results, integration of 100 per cent RDF with 0.5 per cent boron and 5 per cent Jeevamrutha applied as foliar spray at 15-day intervals can be recommended to achieve superior vegetative growth of stevia.

***Key words*:** *Stevia rebaudiana*; Boron; Jeevamrutha; Growth parameters; Foliar spray

Introduction

Diabetes mellitus is one of the most significant public health concerns of the twenty-first century, with an estimated 589 million adults living with the disease globally in 2024 and nearly 89.8 million cases in India alone (International Diabetes Federation, 2025). The rising burden of diabetes and associated lifestyle disorders has increased the demand for healthier, low-calorie sugar substitutes. Stevia (*Stevia rebaudiana* Bertoni) a perennial herb of the family Asteraceae native to Paraguay, has emerged as a promising natural sweetener owing to the presence of diterpene steviol glycosides in its leaves, which are 200-300 times sweeter than sucrose. It also contributes negligible calories, making the crop suitable for diabetic and health-conscious consumers (Lemus-Mondaca *et al.*, 2012). The leaves of stevia contain a mixture of steviol glycosides, including stevioside and rebaudiosides A, B, C, D and E, derived from the tetracyclic diterpene steviol (Brandle *et al.*, 1998). The vegetative growth depends on an efficient and balanced

nutrient management, since stevia is a leafy crop with a relatively shallow, fibrous root system and a high nutrient demand during its vegetative phase.

Among primary nutrients, nitrogen, phosphorus and potassium (NPK) regulate vegetative growth, chlorophyll synthesis, root development and enzyme activation, and their continuous, imbalanced application without complementary micronutrient and organic inputs can deteriorate soil quality and reduce nutrient use efficiency over time (Wanjari *et al.*, 2022). However, micronutrients particularly, boron plays an important role in cell wall formation, meristematic activity, pollen germination and carbohydrate translocation and its deficiency is known to markedly reduce crop growth, yield and quality (Abde Sherefu and Israel Zewide, 2021). Besides, there is growing interest in eco-friendly organic bio-stimulants such as Jeevamrutha, a fermented liquid formulation prepared from cow dung, cow urine, jaggery, pulse flour and rhizospheric soil that enriches the soil rhizosphere with beneficial microorganisms and improves nitrogen fixation, phosphorus solubilization and overall nutrient availability (Devakumar *et al.*, 2014; Sreenivasa *et al.*, 2010). Jeevamrutha has been reported to improve soil fertility, plant growth and crop productivity while reducing dependence on chemical fertilizers (Kulkarni and Gargelwar, 2019; Duraivadivel *et al.*, 2022), and its integration with inorganic nutrients has recently been shown to enhance growth and yield attributes in other medicinal and aromatic crops, such as senna (Jnanesha *et al.*, 2024).

Keeping this in view, the present investigation was undertaken to study the effect of different levels of primary nutrients, boron and Jeevamrutha on the growth parameters, namely plant height, number of branches per plant, number of leaves per plant and plant spread of stevia grown under the North-Eastern transitional tract of Karnataka.

Material and Methods

The field experiment was conducted during 2025-26 at a farmer's field located in the vicinity of College of Horticulture, Bidar, University of Horticultural Sciences, Udyanagiri, Bagalkot, situated in the north-eastern transitional zone (Zone-I) of Karnataka. The experiment was laid out in a randomized complete block design (RCBD) with 13 treatments, replicated thrice by using the variety GKVK Stevia^{-1} at a spacing of 45 cm × 30 cm. The gross and net plot sizes were 2.70 m × 1.80 m and 2.25 m × 1.50 m respectively and the crop was planted in October 2025. The recommended dose of fertilizers (RDF) for stevia was 60:30:45 kg NPK/ha and the treatment details were as follows: T_1 - 50% RDF + 0.25% boron; T_2 - 50% RDF + 0.25% boron + 5% Jeevamrutha; T_3 - 50% RDF + 0.5% boron; T_4 - 50% RDF + 0.5% boron + 5% Jeevamrutha; T_5 - 75% RDF + 0.25% boron; T_6 - 75% RDF + 0.25% boron + 5% Jeevamrutha; T_7 - 75% RDF + 0.5% boron; T_8 - 75% RDF + 0.5% boron + 5% Jeevamrutha; T_9 - 100% RDF + 0.25% boron; T_{10} - 100% RDF + 0.25% boron + 5% Jeevamrutha; T_{11} - 100% RDF + 0.5% boron; T_{12} - 100% RDF + 0.5% boron + 5% Jeevamrutha and T_{13} - 100% RDF (control). Boron (0.25% or 0.5% solution) sourced from borax and Jeevamrutha (5%) were applied as foliar sprays at 15-day intervals. The data recorded for all the growth parameters were statistically analysed following the analysis of variance (ANOVA) technique applicable to RCBD as described by Panse and Sukhatme (1967). Treatment effects were tested using the F-test at 5 per cent probability and the critical difference (CD) at 5 per cent.

Table 1: Influence of different levels of primary nutrients (NPK), boron and Jeevamrutha on plant height (cm) at different stages of crop growth in stevia.

Treatments	30 DAP	60 DAP	90 DAP
T_1 - 50% RDF + 0.25% Boron	24.12	28.51	38.12
T_2 - 50% RDF + 0.25% Boron + 5% Jeevamrutha	25.40	29.22	39.20
T_3 - 50% RDF + 0.5% Boron	24.42	28.70	38.22
T_4 - 50% RDF + 0.5% Boron + 5% Jeevamrutha	25.70	29.51	39.40
T_5 - 75% RDF + 0.25% Boron	26.90	31.80	40.60
T_6 - 75% RDF + 0.25% Boron + 5% Jeevamrutha	27.74	32.40	41.01
T_7 - 75% RDF + 0.5% Boron	27.12	32.01	40.80
T_8 - 75% RDF + 0.5% Boron + 5% Jeevamrutha	27.90	32.40	41.31
T_9 - 100% RDF + 0.25% Boron	28.70	33.40	42.01
T_{10} - 100% RDF + 0.25% Boron + 5% Jeevamrutha	30.01	35.12	43.80
T_{11} - 100% RDF + 0.5% Boron	28.90	33.50	42.11
T_{12} - 100% RDF + 0.5% Boron + 5% Jeevamrutha	30.30	35.60	44.11
T_{13} - 100% RDF (control)	28.50	33.10	41.90
S.Em ±	**0.45**	**0.48**	**0.66**
C.D. at 5%	**1.32**	**1.41**	**1.93**

50% RDF (NPK) = 30:15:22.5 kg/ha; 75% RDF (NPK) = 45:22.5:33.75 kg/ha; 100% RDF (NPK) = 60:30:45 kg/ha; 0.25% Boron = 2.5 g/l; 0.5% Boron = 5 g/l; 5% Jeevamrutha = 50 ml/l; DAP = Days After Planting.

Results and Discussion

Plant height (cm)

Plant height was significantly influenced by different

Table 2: Influence of different levels of primary nutrients (NPK), boron and Jeevamrutha on number of branches plant^{-1} at different stages of crop growth in stevia.

Treatments	30 DAP	60 DAP	90 DAP
T_1 - 50% RDF + 0.25% Boron	9.30	17.24	30.15
T_2 - 50% RDF + 0.25% Boron + 5% Jeevamrutha	10.15	19.21	32.46
T_3 - 50% RDF + 0.5% Boron	9.51	18.32	30.55
T_4 - 50% RDF + 0.5% Boron + 5% Jeevamrutha	10.45	19.71	33.15
T_5 - 75% RDF + 0.25% Boron	12.51	21.53	35.46
T_6 - 75% RDF + 0.25% Boron + 5% Jeevamrutha	13.73	23.44	37.32
T_7 - 75% RDF + 0.5% Boron	12.82	20.35	36.74
T_8 - 75% RDF + 0.5% Boron + 5% Jeevamrutha	14.31	24.32	37.41
T_9 - 100% RDF + 0.25% Boron	16.85	26.25	39.45
T_{10} - 100% RDF + 0.25% Boron + 5% Jeevamrutha	18.05	28.57	40.39
T_{11} - 100% RDF + 0.5% Boron	17.25	26.89	39.83
T_{12} - 100% RDF + 0.5% Boron + 5% Jeevamrutha	18.95	29.86	42.10
T_{13} - 100% RDF (control)	16.45	25.45	39.15
S.Em ±	**0.24**	**0.33**	**0.58**
C.D. at 5%	**0.69**	**0.95**	**1.68**

50% RDF (NPK) = 30:15:22.5 kg/ha; 75% RDF (NPK) = 45:22.5:33.75 kg/ha; 100% RDF (NPK) = 60:30:45 kg/ha; 0.25% Boron = 2.5 g/l; 0.5% Boron = 5 g/l; 5% Jeevamrutha = 50 ml/l; DAP = Days After Planting.

Table 3: Number of leaves per plant of stevia at different stages as influenced by NPK level, boron and Jeevamrutha.

Treatments	30 DAP	60 DAP	90 DAP
T_1 - 50% RDF + 0.25% Boron	95.21	135.72	266.60
T_2 - 50% RDF + 0.25% Boron + 5% Jeevamrutha	110.12	145.23	271.31
T_3 - 50% RDF + 0.5% Boron	99.51	138.80	269.92
T_4 - 50% RDF + 0.5% Boron + 5% Jeevamrutha	112.80	147.91	282.41
T_5 - 75% RDF + 0.25% Boron	120.61	205.10	325.61
T_6 - 75% RDF + 0.25% Boron + 5% Jeevamrutha	134.40	225.93	341.12
T_7 - 75% RDF + 0.5% Boron	125.92	209.52	331.41
T_8 - 75% RDF + 0.5% Boron + 5% Jeevamrutha	140.21	230.01	347.22
T_9 - 100% RDF + 0.25% Boron	146.70	245.83	415.41
T_{10} - 100% RDF + 0.25% Boron + 5% Jeevamrutha	152.82	251.92	432.90
T_{11} - 100% RDF + 0.5% Boron	149.95	248.40	421.32
T_{12} - 100% RDF + 0.5% Boron + 5% Jeevamrutha	157.12	259.74	441.51
T_{13} - 100% RDF (control)	144.72	241.40	417.81
S.Em ±	**1.78**	**3.17**	**4.14**
C.D. at 5%	**5.34**	**9.36**	**14.84**

50% RDF (NPK) = 30:15:22.5 kg/ha; 75% RDF (NPK) = 45:22.5:33.75 kg/ha; 100% RDF (NPK) = 60:30:45 kg/ha; 0.25% Boron = 2.5 g/l; 0.5% Boron = 5 g/l; 5% Jeevamrutha = 50 ml/l; DAP = Days After Planting.

levels of primary nutrients, boron and Jeevamrutha at all the crop growth stages (Table 1). At 90 DAP, the maximum plant height (44.11 cm) was recorded in T_{12} (100% RDF + 0.5% boron + 5% Jeevamrutha), which was statistically on par with T_{10} (100% RDF + 0.25% boron + 5% Jeevamrutha) recording 43.80 cm, whereas the minimum plant height (38.12 cm) was recorded in T_1 (50% RDF + 0.25% boron). A similar trend was observed at 30 and 60 DAP, with T_{12} consistently recording the tallest plants throughout the growth period. The superior plant height recorded under T_{12} may be attributed to the combined effect of adequate NPK nutrition and foliar application of boron and Jeevamrutha. Adequate nitrogen availability promoted chlorophyll synthesis and protein formation, leading to enhanced photosynthetic activity and cell division, while phosphorus ensures efficient energy transfer and potassium facilitates enzyme activation and translocation of photosynthates to actively growing tissues. Foliar boron further enhances meristematic activity, cell wall formation and carbohydrate movement, thereby promoting stem elongation, while Jeevamrutha, as a foliar bio-stimulant, likely improved physiological efficiency through naturally occurring growth-promoting substances. The minimum plant height recorded under T_1 may be ascribed to the reduced availability of primary nutrients (Aladakatti *et al.*, 2012) coupled with the lower boron level and absence of Jeevamrutha. Similar improvements in plant height of stevia with combined nutrient and boron management have been reported by Yang *et al.*, (2025) and Sniegowska *et al.*, (2024), while Jnanesha *et al.*, (2024) recorded a comparable response to Jeevamrutha-based nutrient management in senna.

Number of branches per plant

The number of branches per plant was significantly influenced by the treatments at all the growth stages (Table 2). At 90 DAP, the maximum number of branches per plant (42.10) was recorded in T_{12}, followed by T_{10} (40.39) and T_{11} (39.83). The lowest number of branches per plant (30.15) was recorded in T_1. The higher branching recorded under T_{12} may be attributed to the balanced supply of primary nutrients along with foliar boron and Jeevamrutha, which together promoted the initiation and

Table 4: Influence of different levels of primary nutrients (NPK), boron and Jeevamrutha on plant spread (cm²) at different stages of crop growth in stevia.

Treatments	30 DAP	60 DAP	90 DAP
T_1 - 50% RDF + 0.25% Boron	56.72	97.25	140.52
T_2 - 50% RDF + 0.25% Boron + 5% Jeevamrutha	61.54	102.71	145.34
T_3 - 50% RDF + 0.5% Boron	57.42	98.15	141.98
T_4 - 50% RDF + 0.5% Boron + 5% Jeevamrutha	62.25	101.23	146.51
T_5 - 75% RDF + 0.25% Boron	72.24	112.62	157.62
T_6 - 75% RDF + 0.25% Boron + 5% Jeevamrutha	76.24	117.28	164.72
T_7 - 75% RDF + 0.5% Boron	73.12	113.65	159.61
T_8 - 75% RDF + 0.5% Boron + 5% Jeevamrutha	77.82	118.64	166.75
T_9 - 100% RDF + 0.25% Boron	85.35	130.32	180.52
T_{10} - 100% RDF + 0.25% Boron + 5% Jeevamrutha	95.82	136.69	190.95
T_{11} - 100% RDF + 0.5% Boron	86.12	132.15	182.45
T_{12} - 100% RDF + 0.5% Boron + 5% Jeevamrutha	96.92	138.32	192.68
T_{13} - 100% RDF (control)	85.62	129.95	189.21
S.Em ±	**1.26**	**1.75**	**2.35**
C.D. at 5%	**3.68**	**5.12**	**6.86**

50% RDF (NPK) = 30:15:22.5 kg/ha; 75% RDF (NPK) = 45:22.5:33.75 kg/ha; 100% RDF (NPK) = 60:30:45 kg/ha; 0.25% Boron = 2.5 g/l; 0.5% Boron = 5 g/l; 5% Jeevamrutha = 50 ml/l; DAP = Days After Planting.

development of axillary buds. Boron plays a vital role in cell differentiation, meristem development and carbohydrate transport, thereby supporting the emergence of new branches, while adequate nutrient availability ensured efficient partitioning of photosynthates towards lateral growing points. In contrast, the lower branching recorded under T_1 could be due to inadequate nitrogen availability restricting the production of new meristematic tissue and lower boron limiting carbohydrate translocation to axillary buds and due to lack of Jeevamrutha. Similar results were reported by Yang *et al.*, (2025) in stevia following foliar application of boron, while Jnanesha *et al.*, (2024) and Belagumpi *et al.*, (2025) recorded similarly enhanced branching in senna and sacred basil respectively, following Jeevamrutha-based nutrient management.

Number of leaves per plant

Number of leaves per plant differed significantly among treatments at all three growth stages (30, 60 and 90 DAP) (Table 3). At 90 DAP, T_{12} (100% RDF + 0.5% boron + 5% Jeevamrutha) recorded the highest leaf number (441.51 plant^{-1}), on par with T_{10} (432.90), while T_1 (50% RDF + 0.25% boron) recorded the lowest (266.60). The higher leaf number in T_{12} is attributable to the combined effect of the full NPK dose, which supports cell division and meristematic activity, along with boron aiding assimilate translocation and Jeevamrutha supplying beneficial microorganisms and growth-promoting metabolites to enhance nutrient availability. Similar increases in leaf number with higher NPK levels have been reported in stevia by Aladakatti *et al.*, (2012) and Mohammed *et al.*, (2019), and with Jeevamrutha application in kalmegh by Gowda *et al.*, (2025). The lowest leaf number in T_1 reflects the limitation imposed by inadequate nutrient supply on vegetative growth, noted by Debarba *et al.*, (2021) under low-nutrient conditions in stevia.

Plant spread (cm²)

Plant spread was significantly influenced by different levels of primary nutrients, boron and Jeevamrutha at all the growth stages (Table 4). At 90 DAP, the maximum plant spread (192.68 cm²) was recorded in T_{12}, which was statistically on par with T_{10} (190.95 cm²). The minimum plant spread (140.52 cm²) was recorded in T_1. The greater plant spread recorded under T_{12} may be due to the balanced nutrient supply along with foliar boron and Jeevamrutha, which promoted vigorous lateral growth and uniform canopy development. The increased plant spread observed under T_{12} was also closely associated with the greater number of branches recorded under the same treatment. The minimum plant spread recorded under T_1 could be attributed to restricted vegetative growth arising from lower nutrient supply and the absence of Jeevamrutha. Similar findings on improved canopy development with organic nutrient management have been reported by Belagumpi *et al.*, (2025) in sacred basil and Bhupenchandra *et al.*, (2025), who observed improved canopy growth by following optimal boron management.

Conclusion

The present study demonstrated that INM had a significant influence on the growth attributes of stevia (*Stevia rebaudiana* Bertoni). The combined application of primary nutrients, boron and Jeevamrutha promoted vigorous vegetative growth as reflected by improved plant height, number of branches per plant, number of leaves per plant and plant spread. The results indicated that the integration of inorganic nutrients with organic and biologically active inputs can provide a more balanced nutritional environment for stevia and support sustained vegetative growth. Application of (100%) RDF along with (0.5%) boron and (5%) Jeevamrutha (T_{12}) consistently recorded the highest values for all growth parameters

throughout the crop growth period. The integration of an adequate dose of primary nutrients with foliar boron at (0.5%) and the organic bio-stimulant Jeevamrutha can therefore, be recommended as an effective nutrient management strategy for achieving superior vegetative growth of stevia. Thus, an appropriately optimized integrated nutrient management strategy offers considerable potential for improving growth and biomass production of stevia under the agro-climatic conditions of the North-Eastern Transitional zone of Karnataka.

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