

Effect of date of planting on the growth and leaf yield of *Stevia (Stevia rebaudiana)*

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Abstract

An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh from December 2009 to March 2011 to determine the effect of date of planting on growth and leaf yield of *Stevia*. The experiment comprised 24 dates of planting in the year of 2010 viz. 1 January (T₁), 15 January (T₂), 1 February (T₃), 15 February (T₄), 1 March (T₅), 15 March (T₆), 1 April (T₇), 15 April (T₈), 1 May (T₉), 15 May (T₁₀), 1 June (T₁₁), 15 June (T₁₂), 1 July (T₁₃), 15 July (T₁₄), 1 August (T₁₅), 15 August (T₁₆), 1 September (T₁₇), 15 September (T₁₈), 1 October (T₁₉), 15 October (T₂₀), 1 November (T₂₁), 15 November (T₂₂), 1 December (T₂₃) and 15 December (T₂₄). The experiment was laid out in a Complete Randomized Design with three replications. Twenty four dates of planting were included in the experiment in 72 earthen pots (24 X 3) of 30 cm diameter X 30 cm height. Stem cuttings were placed in shaded seed bed for root initiation. Twenty one - day old stem cuttings were used as planting material. Stem cuttings were transplanted in the pots on the specific dates. Different dates of planting had significant effect on the growth and yield parameters. 1 April 2010 (T₇) planting proved to be the superior to the other treatments i.e. plant height (68.50cm), number of leaves plant⁻¹ (142.33), number of primary branches plant⁻¹ (37.33), fresh weight of leaves plant⁻¹ (14.11g), fresh weight of primary and secondary branches plant⁻¹ (11.06g and 20.91g), dry weight of leaves plant⁻¹ (3.38g) which might be due to warm environmental conditions like clear sunshine and high temperature. The overall results suggested that *stevia* seedlings may be planted from 15 February to 30 April for better yield of leaves.

Keywords: Date of planting, Yield, *Stevia*

Introduction

Stevia is a sweet herb commonly known as “honey leaf” in Indian market (Rayaguru and Khan, 2008). *Stevia* is gaining significant popularity in different parts of the world and is expected to be a major source of high potency sweetener. *Stevia* is a small, semi-bushy, perennial shrub of Compositae family originated in Paraguay. Centuries ago, the natives of Paraguay used the leaves of this herb to sweeten their bitter drinks. It is one of 154 members of the genus *Stevia*, which produces sweet stevioside, diterpenoid glycoside in the leaves of this plant (Soejarto *et al.*, 1982). The plant is native to the valley of the Rio Monday of Paraguay, where it grows in sandy soils near the streams (Katayma *et al.*, 1976). Eight diterpenoid glycosides with sweetening properties have been identified in leaf tissues of *Stevia* (Kinghorn, 1987). The four major sweeteners are stevioside, rebaudioside A, rebaudioside C and dulcoside A. The sweetness of those compounds in relation to sucrose is 210, 242, 30 and 30 times more, respectively. The yield of sweetening compounds present in leaf tissues may vary according to the method of propagation (Tamura *et al.*, 1984) and day-length (Metiyier and Viana, 1979).

Stevia is nutrient-rich, having substantial amount of protein, calcium, phosphorous and other nutrient elements (Viana and Metiyier, 1980). Individual leaves and pieces of leaf can be added to beverage, salads or cooking vegetables and substituted for sugar in recipes without creating a problem due to the presence of the leaf itself.

Diabetic is a serious problematic disease throughout the world and diabetic patient cannot take sweet substances like sugar, glucose and sucrose etc. In Bangladesh about 80 lakhs of 20 to 69 year aged people are suffering from this serious disease which is about 5.9% of total population. But the most alarming message is a good number of children aged from 8 to 20 year are also suffering from this serious disease. The sweet substances present in *stevia* are not harmful for the diabetic patient. Under this situation *stevia* can help this huge number of people and in addition to this it can also contribute to the national economy by replacing sugar to a great extent.

Seed germination of Stevia is poor sometimes it even less than 10% (Miyazaki and Wantenabe, 1974). There are two options for its multiplication. The first one is the tissue culture and the other is stem cutting. Sophisticated equipments are involved in tissue culture technique. That is why tissue culture method is not possible for the common farmers of this country for Stevia propagation. Besides, due to illiteracy and socioeconomic condition of farmers in Bangladesh is not possible for tissue culture but stem cutting technique will be an appropriate method for propagation in Stevia.

Stevia plant has been discovered by Bertoni in 1864. But in Bangladesh it was first imported in the year 2001 by Bangladesh Sugarcane Research Institute (BSRI). Some preliminary experiments on morphological and physiological parameters have been conducted at BSRI. In the recent years BSRI and Bangladesh Rural Advanced Committee (BRAC), Gazipur, have performed various laboratory experiments especially on tissue culture technique and have developed a method of *In vitro* production of stevia seedling. A field experiment was conducted in 2008 at the Department of Agronomy, Bangladesh Agricultural University (BAU), to identify fertilizer dose and spacing. Except this, no field experiment has yet been done in the country. So it is still mysterious to the people about the exact date of planting. Hence, the prevailing situation underscores the need for a research to study the effect of planting dates of stevia observed under the field condition of Bangladesh. The present study was, therefore, undertaken to the effect of planting date on the growth and leaf yield of Stevia.

Materials and Methods

The experiment was conducted at the Agronomy Field Laboratory, BAU, Mymensingh from December 2009 to March 2011 to determine the effect of date of planting on the growth and leaf yield of Stevia. The experimental area was characterized by non-calcareous dark grey floodplain soil belonging to the sonatola soil series under the Old Brahmaputra Floodplain (AEZ-9) (UNDP and FAO 1988). The experiment comprised 24 dates of planting in the year of 2010 viz. 1 January (T₁), 15 January (T₂), 1 February (T₃), 15 February (T₄), 1 March (T₅), 15 March (T₆), 1 April (T₇), 15 April (T₈), 1 May (T₉), 15 May (T₁₀), 1 June (T₁₁), 15 June (T₁₂), 1 July (T₁₃), 15 July (T₁₄), 1 August (T₁₅), 15 August (T₁₆), 1 September (T₁₇), 15 September (T₁₈), 1 October (T₁₉), 15 October (T₂₀), 1 November (T₂₁), 15 November (T₂₂), 1 December (T₂₃) and 15 December (T₂₄). The experiment was laid out in a completely randomized design with three replications. Twenty four dates of planting were included in the experiment in 72 earthen pots (24 X 3) of 30 cm diameter X 30 cm height. Pots were placed in 3 rows. Stem cuttings were collected from mother plant of Stevia. Stem cuttings were placed in shaded seed bed for root initiation. Twenty one-day old stem cuttings were planted in the experiment. Three stem cuttings were planted in each pot. A common dose of NPKS @ 48, 12, 16, 6 kg ha⁻¹, respectively was used in the experimental pots. Intercultural operations like weeding and irrigation were done as and when necessary. At harvest one plant was selected for recording data. Data were collected on plant height (cm), number of leaves plant⁻¹, number of primary and secondary branches plant⁻¹, fresh weight of leaf plant⁻¹ (g), fresh weight of primary and secondary branches plant⁻¹ (g), fresh weight of plant pot⁻¹, dry weight of leaves plant⁻¹ (g) and dry weight of plant pot⁻¹ (g). Recorded data were compiled and tabulated in proper form. The data were analyzed statistically using "Analyses of Variance" technique and mean differences were adjudged by Duncan's Multiple Range Test (Gomez and Gomez, 1984) with the help of computer package program MSTAT-C.

Results and Discussion

Effect of date of planting

Plant height (cm): The data pertaining to plant height at different growth stages enhanced due to dates of planting are presented in Fig. 1. Significant differences were resulted due to different dates of planting with respect to plant height. The plant height continuously increased with the advancement of dates from 1 January (T₁) to 15 April (T₈) which might be due to high temperature and more intensity of light and was significantly lower from 1 May (T₉) to 15 December (T₂₄).

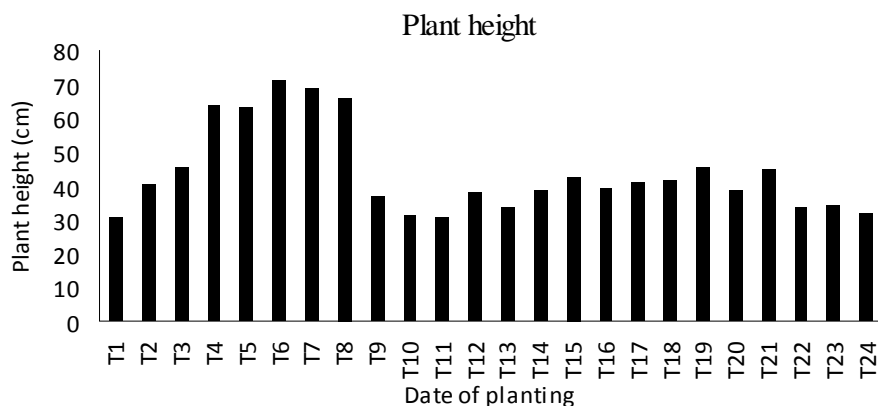


Fig. 1. Effect of date of planting on plant height

Among the twenty four dates of planting, 15 March 2010 (T₆) recorded the highest plant height (70.83 cm), which was statistically identical with T₄, T₅, T₇ and T₈ while, the plants of 1 January 2010 planting (T₁) recorded the lowest plant height (30.67 cm), which was identical with T₉, T₁₀, T₁₁, T₁₂, T₁₃, T₁₄, T₁₆, T₂₀, T₂₂, T₂₃, and T₂₄. Plant height differed in different dates of planting. It might be due to variation of light, air and moisture in different dates of planting.

Number of leaves plant⁻¹: The data pertaining number of leaves plant⁻¹ at different growth stages as influenced by dates of planting is presented in Fig. 2. Significant differences with respect to number of leaves were recorded due to different dates of planting.

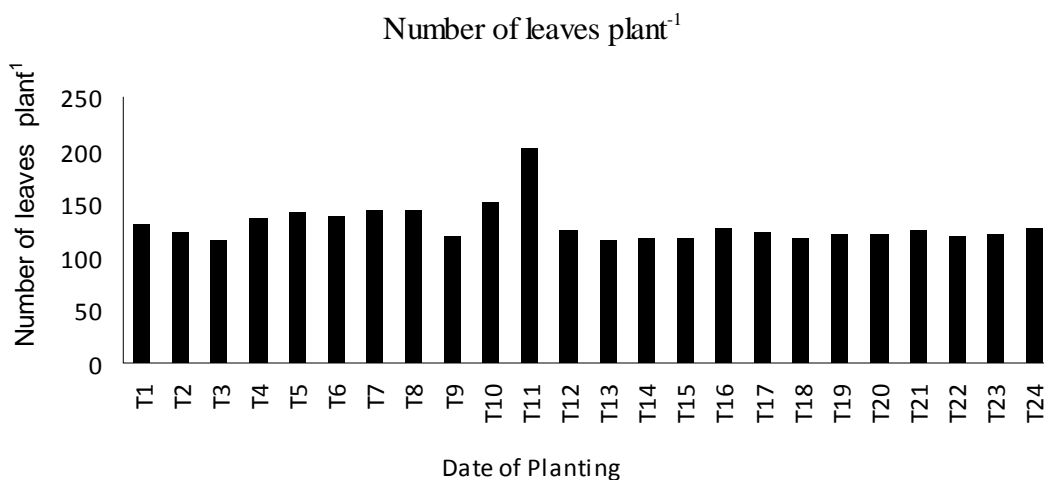


Fig. 2. Effect of date of planting on number of leaves plant⁻¹

The plants of 1 June (T₁₁) recorded increased number of leaves (201.33) which was statistically identical with T₅, T₇, T₈ and T₁₀. Whereas, decreased number of leaves (114.33) were recorded from 1 February 2010 (T₃) planting which was statistically identical with T₁, T₂, T₉, T₁₂, T₁₃, T₁₄, T₁₅, T₁₆, T₁₇, T₁₈, T₁₉, T₂₀, T₂₁, T₂₂, T₂₃ and T₂₄. 1 March to 1 June date of planting showed highest leaves plant⁻¹ due to best favorable environmental condition.

Number of primary branches plant⁻¹: The data on number of primary branches plant⁻¹ at harvest significantly influenced by dates of planting (Table 1). At harvest, the number of primary branches plant⁻¹ was maximum in 1 April planting (T₇) (37.33) which was statistically identical with T₄, T₅, T₆, T₇ and T₈. while it was the lowest in 1 November (T₂₁) planting (16.67).

Number of secondary branches plant⁻¹: The data on number of secondary branches plant⁻¹ at harvest as influenced by dates of planting is shown in Table 1. At harvest, the number of secondary branches plant⁻¹ was significantly maximum in 15 September planting (T₁₈) (51.96) which was statistically identical to T₈, while it was the lowest in 15 June (T₁₂) planting (25.61).

Table 1. Effect of date of planting on the growth and leaf yield of Stevia

Date of Planting	Primary branches plant ⁻¹ (no.)	Secondary branches plant ⁻¹ (no.)	Fresh wt. of primary branches plant ⁻¹ (g)	Fresh wt. of secondary branches plant ⁻¹ (g)	Fresh wt. of plant pot ⁻¹ (g)	Dry wt. of plant pot ⁻¹ (g)
T ₁	24.33b-e	36.47d-i	6.67cd	14.93c-g	43.52	11.37
T ₂	21.67 b-e	36.87d-i	8.80a-d	17.67a-d	12.12	5.89
T ₃	17.00e	36.01e-j	7.07bcd	15.33c-g	13.64	4.57
T ₄	29.67ab	43.45bcd	9.91abc	18.69abc	24.46	6.19
T ₅	34.67a	44.45bc	10.89a	20.36ab	30.42	7.46
T ₆	28.67abc	43.34b-e	10.32ab	20.33ab	31.63	8.06
T ₇	37.33a	43.38b-e	11.06a	20.91a	44.63	13.70
T ₈	28.33a-d	48.10ab	10.40ab	20.44ab	16.56	4.86
T ₉	23.67 b-e	31.49ij	7.40bcd	15.53c-g	16.98	4.15
T ₁₀	21.33 b-e	32.98hij	6.87cd	15.20c-g	32.80	8.70
T ₁₁	24.33 b-e	36.78d-i	8.20a-d	15.80c-g	43.52	11.37
T ₁₂	18.67de	25.61k	6.87cd	16.07c-g	29.52	6.09
T ₁₃	20.00 b-e	41.77b-f	8.27a-d	16.20c-g	15.64	2.26
T ₁₄	24.67 b-e	44.26bc	5.93d	13.73efg	33.60	9.46
T ₁₅	22.33 b-e	29.22j	9.30a-d	17.10b-f	10.20	4.45
T ₁₆	20.33 b-e	33.62g-i	9.86abc	17.55a-e	19.52	5.27
T ₁₇	20.67 b-e	38.71c-h	6.48cd	15.07c-g	17.37	6.27
T ₁₈	20.33 b-e	51.96a	7.08bcd	14.27c-g	13.51	5.43
T ₁₉	17.00e	35.58e-j	9.15a-d	13.20fg	11.19	3.43
T ₂₀	19.67cde	36.90d-i	9.30a-d	13.80efg	17.28	5.37
T ₂₁	16.67e	39.81c-h	9.87abc	15.27c-g	19.97	4.01
T ₂₂	22.67 b-e	39.01c-h	8.80a-d	12.47g	18.31	4.80
T ₂₃	22.33 b-e	42.31b-f	9.18a-d	14.98c-g	25.56	8.16
T ₂₄	19.67cde	40.67c-g	8.66a-d	17.33a-e	26.68	7.04
CV (%)	17.62	2.02	2.81	2.04	18.12	19.66
Level of significance	**	**	**	**	NS	NS

In a column figures having common letter(s) do not differ significantly as per DMRT.

** indicates 1% level of probability, NS indicates not significant.

T ₁ =1 January 2010	T ₇ =1 April 2010	T ₁₃ =1 July 2010	T ₁₉ =1 October 2010
T ₂ =15 January 2010	T ₈ =15 April 2010	T ₁₄ =15 July 2010	T ₂₀ =15 October 2010
T ₃ =1 February 2010	T ₉ =1 May 2010	T ₁₅ =1 August 2010	T ₂₁ =1 November 2010
T ₄ =15 February 2010	T ₁₀ =15 May 2010	T ₁₆ =15 August 2010	T ₂₂ =15 November 2010
T ₅ =1 March 2010	T ₁₁ =1 June 2010	T ₁₇ =1 September 2010	T ₂₃ =1 December 2010
T ₆ =15 March 2010	T ₁₂ =15 June 2010	T ₁₈ =15 September 2010	T ₂₄ =15 December 2010

Fresh weight of leaves plant⁻¹(g): The data pertaining to fresh weight of leaves plant⁻¹ as influenced by dates of planting are presented in Fig. 3. The dates of planting showed significant variation in influencing the fresh weight of leaves plant⁻¹. The fresh weight of leaves plant⁻¹ decreased from 1 January to 1 February which might be due to cold weather condition and after that it was continuously increased with the advancement of dates from 1 February (T₂) to 1 April (T₇) which might be due to increased temperature and intensity of light. During the cold winter stevia plants bears small, white flowers and arranged in an irregular cyme. In the months of December and January the plants were characterized by heavy flowering and low leaf production which ultimately reduced the leaf yield. Significantly higher fresh weight of leaf plant⁻¹ (14.11g) was noticed from plants of 1 April planting (T₇) while those of 1 November planting recorded significantly lower fresh yield (2.38g).

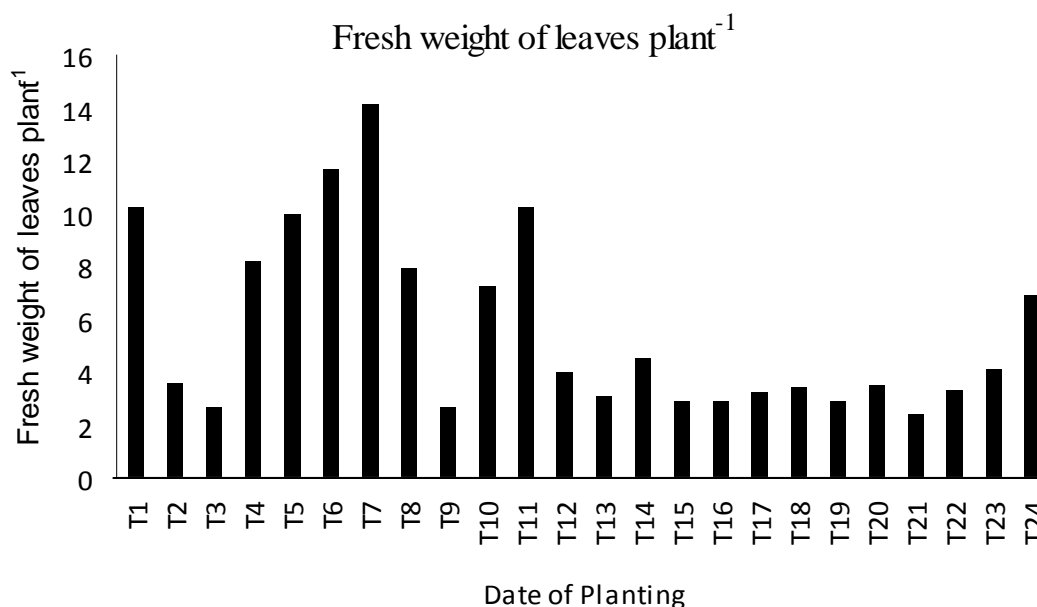


Fig. 3. Effect of date of planting on fresh weight of leaf plant⁻¹

Fresh weight of primary branches plant⁻¹(g): The dates of planting exerted significant effect on fresh wt. of primary branches plant⁻¹. The highest fresh wt. of primary branches plant⁻¹ (11.06g) was recorded from 1 April planting (T₇) while significantly lower fresh weight of primary branches plant⁻¹ (5.93g) was recorded in 15 July planting (T₁₄) (Table 1).

Fresh weight of secondary branches plant⁻¹(g): The data pertaining to fresh weight of secondary branches plant⁻¹ as influenced by dates of planting is shown in Table 1. The dates of planting showed significant variation in influencing the fresh weight of secondary branches plant⁻¹. Significantly more fresh weight of secondary branches plant⁻¹ (20.91g) was produced from plants of 1 April planting (T₇), while those of 15 November planting recorded lower fresh weight of secondary branches plant⁻¹ (12.47g) in T₂₂, which was statistically identical to other treatments.

Fresh weight of plant pot⁻¹(g): The dates of planting showed no significant variation in fresh weight of plant pot⁻¹ (Table 1). However, apparently the highest fresh weight of plant pot⁻¹(44.63g) produced in plants of 1 April planting (T₇).

Dry weight of leaves plant⁻¹ (g): The data on dry weight of leaves plant⁻¹ at harvest in this crop as influenced by different dates of planting are presented in Fig. 4. Dry weight of leaves plant⁻¹ continuously increased with the advancement of dates from 15 January (T₂) to 1 April (T₇) and after that it was fluctuating. The different dates of planting significantly recorded higher dry weight of leaves plant⁻¹ (3.38 g) from 1 April planting (T₇) which was statistically similar with T₆ & T₁ while significantly lower dry weight of leaves plant⁻¹ at harvest (0.40g) was recorded in 1 July planting (T₁₃). Stevia plant can't survive in water logging condition, especially in the months from June to August due to heavy rainfall.

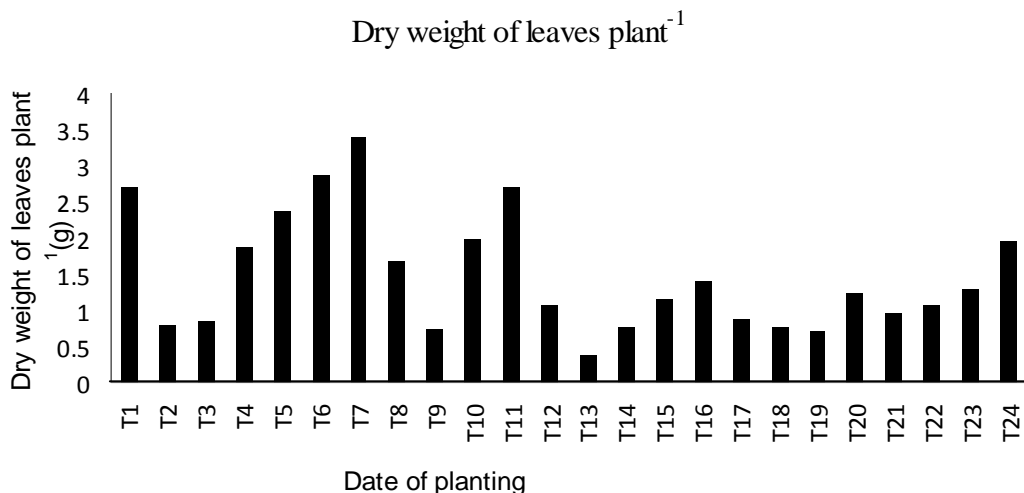


Fig. 4. Effect of date of planting on dry weight of leaves plant⁻¹

Dry weight of plant pot⁻¹(g): The different dates of planting showed non-significant variation in influencing the dry weight of plant pot⁻¹ at harvest (Table 1). Comparing the dry weight of plant pot⁻¹ as influenced by dates of planting it was observed that the highest dry weight of plant pot⁻¹ (13.70 g) was produced in plants of 1 April planting (T₇).

Conclusion

From the above results it is revealed that yield attributes of stevia differed with different dates of planting. The highest fresh weight of leaves plant⁻¹ (14.11g), fresh weight of primary and secondary branches plant⁻¹ (11.06g and 20.91g) and dry weight of leaves plant⁻¹ (3.38g) was produced from 1 April 2010 (T₇) planting. The overall results suggested that stevia seedlings may be planted from 15 February to 30 April for better yield of leaves.

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