International Journal of Economic Plants

https://ojs.pphouse.org/index.php/IJEP

Crossref

IJEP March 2025, 12(2): 01-09

Article IJEP5904b

Full Research

Natural Resource Management

Doi: HTTPS://DOI.ORG/10.23910/2/2025.IJEP5904b

Morphological Attributes and Standardizing Plant Spacings with Harvesting Schedules to Enhance Growth and Yield of *Stevia rebaudiana* Bertoni

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Article History

Received on 30th October, 2024
Received in revised form on 20th January, 2025
Accepted in final form on 07th February, 2025
Published on 25th February, 2025

Abstract

A Field experiment was carried out to study morphological attributes and standardizing plant spacings and harvesting schedules to enhance the growth and yield of *Stevia rebaudiana* in the experimental field as well as in laboratory of the Department of Forest Products, College of Forestry, Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan,Himachal Pradesh (173230), India, from March, 2019- November, 2019. The experiment was conducted under Randomized Block Design (Factorial) with three replications, four spacing i.e. S_1 (45–30 cm^2), S_2 (45-45 cm^2), S_3 (60-45 cm^2), S_4 (60–60 cm^2) and two harvesting schedules i.e. H_1: 50–60 days after transplanting, H_2: 70–80 days after first harvesting. The narrow plant spacing S_1 (45–30 cm^2) gave maximum total fresh leaf yield (73.33 q ha^{-1}), total dry leaf yield (30.07 q ha^{-1}), total fresh foliage yield (130.53 q ha^{-1}), total dry foliage yield (54.45 q ha^{-1}) and B:C ratio (1.22) as compared to other spacingsin two harvests. Narrow spacing (45-30 cm^2) can be recommended for planting of *Stevia rebaudiana* in order to get better yield and B:C ratio.

Keywords: Benefit cost ratio, morphology, spacings, *Stevia rebaudiana*, yield

1. Introduction

Stevia rebaudiana (*Stevia* genus) is a perennial shrub (2n=22) belonging to family Asteraceae, which is native to tropical South America (Paraguay) (Pal et al., 2013; Zaman et al., 2015; Halim et al., 2016; Verma and Panda, 2018). The history of *Stevia* dates back to the sixteenth century; but officially discovered by Bertoni in 1905 (Das et al., 2007; Zaman et al., 2015). The plant was known and extensively used by the Guarani native population from Paraguay by the name of "Ka'a He 'e" (means sweet herb) (Bender, 2016). *Stevia* has a sweetness that is 100–300 times sweeter than sucrose sugar, which is obtained from sugar cane and sugar beehives (Lemus-Mondaca et al., 2012).

The primary sugar component of *stevia* was found to be stevioside ($C_{38}H_{60}O_{18}$), a steviol glycoside molecule that was isolated from *Stevia* plants. Stevioside is 300 times sweeter than table sugar in terms of relative sweetness. Nevertheless, a number of steviol glycoside components are isolated from *Stevia* to create formulations that include in addition to stevioside, rebaudioside A (Reb A) and other minor steviol glycosides constituents such as rebaudiosides B, C, D, E, F and M, steviolbioside, rubusoside and dulcoside (Bender, 2016; Samsudin and Aziz, 2013). It is known as "calorie free bio-sweetener of high quality" (Preethi et al., 2011), it is safe for diabetics and hypoglycemics being a healthy and natural sweetener (Ahmad et al., 2020; Kumar et al., 2013; Afandi et al., 2013).

This plant produces small, elliptical leaves from brittle stems and anextensive root system. The growth habit of *Stevia* is herbaceous, with alternating leaf arrangement (Singh and Rao, 2005). Leaves are small, sessile, lanceolate to oblanceolate, oblong, serate above the middle and somewhat folded upwards (Shaffert and Chebotar, 1994; Fronza and Folegatti, 2003). The inflorescence is loosely paniculate with the heads emerge in irregular sympodial cymes opposing the bracts. The flowers are small (15–17 mm) and white (Dwivedi, 1999) with pale purple throat corollas. The tiny white florets are perfect (hermaphrodite) having both male and female organs, borne in small corymbs of two to six florets (Goettemoeller and Ching, 1999; Goyal et al., 2010; Miyagawa et al., 1986; Chalapathi et al., 1997; Sharma et al., 2006; Oddone, 1997).

Seeds are contained in slender achenes about 3 mm in length. There are around twenty persistent pappus bristles on each achene (Goettemoeller and Ching, 1999; Shock (1982), Duke (1993), Carneiro et al. (1997) and Lester (1999) reported a poor and highly variable percentage of viable seeds. Fertile seeds are usually dark coloured, whereas infertile seeds are usually pale (1000 seeds weigh 0.3–1.0 g).

Plant spacing is crucial for maintaining the balance of competition between weeds and crops as well as for optimal crop development and output (Walia and Kumar, 2019). Higher leaf dry biomass was observed in candyleaf plants at 45×10 cm^2 spacing beneath the mid-hill area of the northwest Himalayas by Kumar et al. (2014). Narrow spacing increases crop competitive ability and also constrains the time of competition between weeds and crops. It provides accessible moisture to the crop and stifles weed development by closing crop canopy sooner than wider spacing (Kumar et al., 2014).

Stevia production demand from the past decade is rising due to the fast-growing trend in dietary foods and beverages. The plant thus possesses considerable economic value and is in high demand because of its specific pharmacological and pharmaceutical properties.At present not much information is available on the cultivation and agronomic requirements of *Stevia* namely plant population, planting geometry, fertilizer doses, irrigation requirement etc. Therefore, in view of the above, the present investigation were undertaken to find out optimum planting density of *Stevia* in order to achieve high crop yields, high quality level. However, the effect of plant density of *Stevia* is still poorly investigated, with few studies especially under mid hill conditions of Himachal Pradesh.

2. Materials and Methods

2.1. Field trial

Field trial of present study were carried out at the experimental field of Department of Forest Products, Dr Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh (173 230), India, (30°52'N, 77°11'E, 1270 m above MSL) for the two consecutive harvesting seasons (from March, 2019–November, 2019) at the same site. The study area comes under sub-tropical, sub humid agro-climatic zone of Himachal Pradesh, India. During the experimental period, thetemperature at the location ranged from 12.7°C to 33.7°C in summer (April-June/July), from 6.6°C to 25.6°C in winter (March/September-October) and 18.6°C to 28.8°C in rainy season (July/August-September). Maximum relative humidity (79%) was in July and August 2019 followed by September 2019 (78%). The area received maximum rainfall in August 2019 (225.8 mm). The data pertaining to the relevant meteorological parameters recorded at meteorological observatory of Department of Environmental Science, College of Forestry was procured for the periods of experimentation.

Before laying out the experiment, soil samples were collected from 0–15 cm depth from different plots of experimental area. The physico-chemical nutrient status of soil measured before transplanting the seedlings and different soil characteristics such as soil pH (6.73), electrical conductivity, organic carbon (0.95%) determine by Walkley and Black's rapid titration method as described by Piper (1966), available nitrogen (290.45 kg ha^{-1}) by alkaline permanganate method (Subbiah and Asija, 1956), phosphorous (56.34 kg ha^{-1}) by method of Olsen et al. (1954)and potassium (179.76 kg ha^{-1}) by Flame photometer (Merwin and Peech, 1951).

2.1.1. Sowing and transplanting

The seedlings were raised by root cuttings in the month of March-April. Seedlings (height up to 20–25 cm) were transplanted (one month after sowing) to the main field. A crop treatment in a replication occupied 2.4×1.8 m^2 area. The crops were irrigated as and when required. In all, four irrigations were given to the crop. Three manual weeding followed by earthing up were carried out.Full quantity of FYM (N content equivalent to RDF) was applied at the time of field preparation, Basal dose of 30 kg N, 45 kg P_2O_5 and 30 kg K_2O was applied. Second spilt dose of 30 kg N kg^{-1} was applied after one month of transplanting.

2.2. Parameter to be estimated

The measurements made on individual harvests were plant height, number of leaves $plant^{-1}$, number of shoots $plant^{-1}$, leaf and total foliage yield in fresh and dry basis of multi-harvested crop. Cost of cultivation, gross returns, net returns and benefit: cost ratio was also calculated. The cost of cultivation was analyzed on per hectare basis. The requirement of labor and expenses of different operations such as ploughing, harrowing, weeding and harvesting were calculated on the basis of prevalent labor charges. Cost of input like seeds, manures were calculated based on the actual amounts applied to land use system. Gross returns were calculated as the prevailing local market prices were used to convert the yield of the crop. Net returns were calculated by deducting total cost from the gross returns. Benefit: Cost ratio was calculated by dividing gross returns by cost of cultivation given by Desai et al., 2018.

2.3. Treatments

The experiment was conducted under Randomized Block Design (Factorial) with three replications, four spacing i.e. S_1 (45–30 cm^2), S_2 (45–45 cm^2), S_3 (60–45 cm^2) S_4 (60–60 cm^2) and two harvesting schedules i.e. H_1: 50–60 days after transplanting, H_2: 70–80 days after first harvesting. The nursery planting of root cuttings has been carried on 28th March and seedlings were transplanted on 6th May 2019. The bed size was 2.40–1.8 m^2.

3. Results and Discussion

3.1. Mophological attributes

Stevia rebaudiana was observed to be a perennial shrub, having number of shoots arising from underground roots

(Figure 1). New shoots developed in spring season (March–April). Abundant shoots, leaf and flower formation was observed during July–September which was followed by seed formation during August–October. Roots were adventitious. New roots were regularly replaced by older roots and were observed to be thicker than newly formed roots. Stem was erect, cylindrical, with several branches, pubescent, woody at the base. Stem was squarish in upper region and of circular outline in the lower region and having distinct nodes and internodes. Leaves were trinerve having reticulate venation (Figure 2). Trichomes were present on the leaf surface (Figure 3).

Figure 1: Whole plant of *Stevia rebaudiana*

Figure 2: Leaf arrangement and stem with trichomes in *Stevia rebaudiana*

3.1.1. Inflorescence type

Inflorescence of *Stevia rebaudiana* was capitulum or head with disc floret (2–6 floret in each head) surrounded by leaves like structure called involucres (Figure 4). The florets were small and white with pale purple throat corolla. The plant takes more than a month to pass through the various developmental flower stages while producing all its flowers (Figure 5).

3.1.2. *Floral characters*

The tiny white florets were bisexual (hermaphrodite) having both male and female organs, with two to six florets. Flowers were sessile, actinomorphic, pentamerous, tetracyclic, and epigynous.

3.1.3. Fruit type and seed characteristics

Fruit was cypsela (inferior achene), pappus was persistant. Seeds were found to be contained in slender achenes about 3 mm in length. Each achene has about 20 persistent pappus bristles (figure 4). Seeds were very small (1000 seeds weigh 3.70 g) (Table 1).

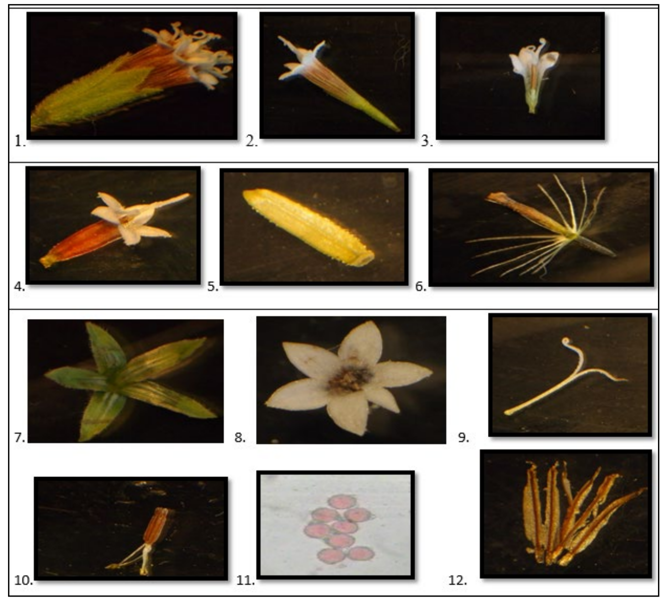

Figure 3: Inflorescence of *Stevia rebaudiana* (1. Whole flower (Disc floret), 2. Single floret, 3. Floret with gynoecium and androecium, 4. Floret without fruit, 5. Fruit, 6. Seed with pappus, 7. Involucre, 8. Corolla, 9. Gynoecium 10. Androecium 11. Pollens, 12. Anthers)

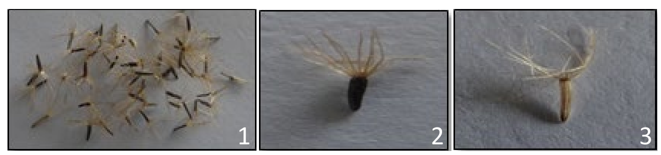

Figure 4: 1: Seeds of *Stevia rebaudiana*; 2: Viable seeds; 3: Non-viable seeds

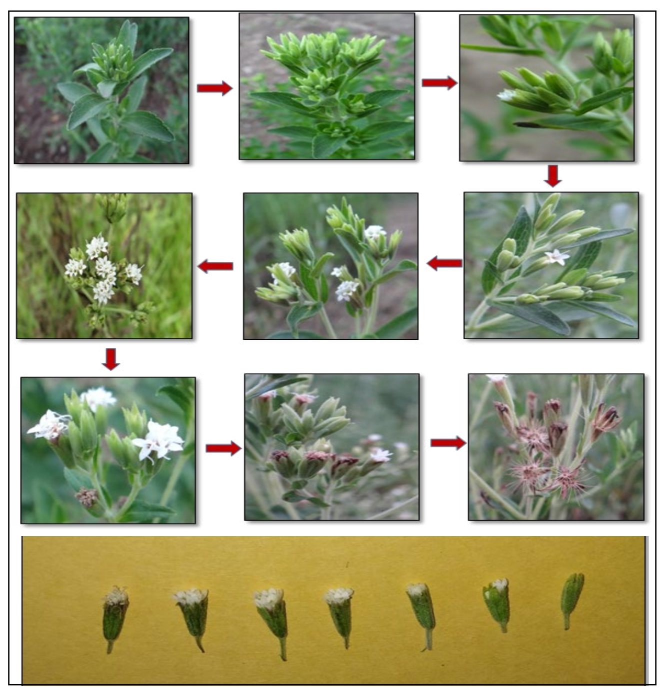

Figure 5: Different development stages of flower in *Stevia rebaudiana*

Table 1: Qualitative and quantitative morphological features of *Stevia rebaudiana*

1. Qualitative features	
Habit	Perennial shrub
Roots	Adventitious, greyish reddish brown colour (200 B)
Stem	Erect, cylindrical, Strong yellow green (144 B)
Leaf	Simple, opposite decussate with ovate to elliptical lanceolate shape.
Adaxial surface	Moderate olive green (137 A)
Abaxial surface	Moderate yellowish green (137 D)
Seeds	Achenes with persistent pappus bristles, dark grayish purple
Viable seeds	(202 A)
Non-viable seeds	moderate yellow (161 A)
2. Quantitative features	
Parameter	Dimension
Plant height (cm)	(range 35.17-95.00 cm)
Shoot diameter (mm)	(range 3.97-9.52 mm)
Root	
Root length (cm)	(range 4.00-7.30 cm)
Root diameter (mm)	(range 1.55-2.45 mm)
Leaf	
Leaf length (cm)	(range 6.60-8.50cm)
Leaf width (cm)	(range 2.90-4.00 cm)
Corolla	
Corolla length (mm)	(range 1.97-4.33 mm)
Corolla width (mm)	(range 0.36-0.83 mm)
Involucre	
Involucre length (mm)	(range 6.26-7.27 mm)
Involucre width (mm)	(range 1.38-1.77 mm)
Pappus	
Pappus length (mm)	(range 3.86-4.22 mm)
Pappus width (mm)	(range 0.126-0.18 mm)
Androecium	
Androecium length (mm)	(range 1.69-2.03 mm)
Androecium width (mm)	(range 0.11 -0.18 mm)
Gynoecium	
Gynoecium length (mm)	(range 1.98-6.81 mm)
Gynoecium width (mm)	(range 0.52-0.68 mm)
Seed	
Seed length (mm)	(range 1.77-6.60 mm)
Seed width (mm)	(range 0.50-0.60 mm)
Pappus and seed length (mm)	(range 6.52-7.70 mm)
Flower/Floret	
Floret length (mm)	(range 7.30-7.69 mm)
Floret width (mm)	(range 0.38-0.85 mm)

Most of the morphological features of plantin the present study are in agreement with the earlier studies by Agarwal and Upadhyaya (2006), Madan et al. (2010), Singh et al. (2015). Similar plant habit in *Stevia* was also reported by Ramesh et al. (2006). According to Kurian and Sankar (2007), heads or capitula of *Stevia* were white and arranged in irregular cyme.

3.2. Effect of plant spacings and harvesting schedules on growth and yield of Stevia rebaudiana

Maximum plant height (61.22 cm) was observed in S_1 during second harvesting (H_2). The maximum number of shoots (13.11) were observed in an interaction of S_4H_2. Table 2 revealed that the maximum number of leaves (196.66) were observed in S_1H_2 and minimum number of leaves (110.66) were recorded in S_4H_1 which was statistically at par with S_3H_1 (115.45) and S_2H_1 (121.78) (Table 2). The maximum value of fresh and dry leaf (Table 3) as well as foliage weight (g) plant^{-1} was observed in S_1H_2 (54.33 g and 23.63 g; 94.67 g and 41.88) (Table 5). Maximum fresh and dry shoot weight plant^{-1} was recorded in S_1 (41.61 g and 19.59 g) (Table 4). The maximum estimated fresh and dry leaf (Table 6) and foliage yield (Table 7) was observed in S_1 (40.24 q ha^{-1} and 17.50 q ha^{-1}; 70.12 q ha^{-1} and 31.02 q ha^{-1}) during second harvesting (H_2).

The maximum cost of cultivation (2, 47,032.00 ₹ ha^{-1}) during both harvesting schedules was recorded in S_1 which was followed by S_2 (2, 41,019.00 ₹ ha^{-1}) and the highest gross return was recorded in S_1 (₹ 3, 00,700.00). The highest net return was recorded in S_1 (₹ 53,668.00) (Table 9).

In present investigation, the increase in dry leaf weight per plant at narrow spacing S_1 (30-45 cm^2) was 94.61% and 122.7% than wider spacing i.e. S_4 (60–60 cm) in first and second harvesting. This might be due to favorable weather condition and extended duration of harvestings. Plant geometry helps to modify the microclimate. Narrow row spacing results in higher leaf photosynthesis and suppresses weed growth due to a smothering effect compared with a wider row spacing (Dwyer et al., 1991). Higher yield in (30–45 cm^2) spacing was reported by Kumar (2009) in *Mentha piperita* and *M. spicata.*

Saini et al. (2001) reported that the higher yield in narrow spacings may be due to large number of plants per unit area and less competition among plants for light, nutrients etc.These results are in confirmation with those reports of Walia and Kumar (2019), Leaf biomass (fresh and dry) and total biomass (leafand stem) were significantly higher in 45×45 cm^2 spacing than 60×45 cm^2 (Table 4). Narrow-spacedplots exhibited 31.0, 32.9 and 40.5% higher mean fresh leaf, dry leaf and total biomass, respectively, than widerspacing. Benhmimou et al. (2017) also reported that increasing in fresh leaf biomass and dry leaf biomass of two harvests were obtained with narrow spacing in *Stevia rebaudiana*. Similarly, maximum plant height, fresh and dry leaf weight in two harvestings reported by Aladakatti et al. (2012) in *Stevia rebaudiana*. Kumar et al. (2012) also reported significantly higher leaf dry biomass at narrow spacings in *Stevia rebaudiana* under mid hill conditions

Table 2: Effect of different plant spacings and harvesting schedules on plant height (cm), number of shoots plant^{-1} and number of leaves

Parameters/ Treatments	Plant height (cm)			No. of shoots plant^{-1}			No. of leaves plant^{-1}		
	H_1	H_2	Pooled data	H_1	H_2	Pooled data	H_1	H_2	Pooled data
S_1 (30–45 cm^2)	40.11	61.22	50.67	2.78	10.00	6.39	169.22	196.66	182.94
S_2 (45–45 cm^2)	40.44	59.22	49.83	3.78	11.00	7.39	121.78	180.89	151.33
S_3 (45–60 cm^2)	36.50	56.22	46.36	4.11	11.33	7.72	115.45	147.67	131.56
S_4 (60–60 cm^2)	35.17	54.22	44.70	4.44	13.11	8.78	110.66	136.67	123.67
Mean	38.06	57.72		3.78	11.36		129.28	165.47	
Factors	CD (p=0.05)			CD (p=0.05)			CD (p=0.05)		
Plant spacings	2.61			1.15			6.96		
Harvesting Schedules	3.69			1.63			9.85		
Plant spacings× Harvesting schedules	NS			NS			13.93		

Table 3: Effect of different plant spacings and harvesting schedules on fresh and dry leaf weight plant^{-1} (g)

Parameters/ Treatments	Fresh leaf weight plant^{-1} (g)			Dry leaf weight plant^{-1} (g)		
	H_1	H_2	Pooled data	H_1	H_2	Pooled data
S_1 (30–45 cm^2)	44.67	54.33	49.50	16.97	23.63	20.30
S_2 (45–45 cm^2)	39.11	52.44	45.78	12.91	20.58	16.75
S_3 (45–60 cm^2)	36.89	43.56	40.22	11.64	14.43	13.04
S_4 (60–60 cm^2)	29.67	32.44	31.06	8.72	10.61	9.66
Mean	37.58	45.69		12.56	17.31	
Factors	CD (p=0.05)			CD (p=0.05)		
Plant spacings	5.21			1.44		
Harvesting schedules	7.37			2.03		
Plant spacings×Harvesting schedules	NS			2.87		

Table 4: Effect of different plant spacings and harvesting schedules on fresh and dry shoot weight plant^{-1} (g)

Parameters/ Treatments	Fresh shoot weight plant^{-1} (g)			Dry shoot weight plant^{-1} (g)		
	H_1	H_2	Pooled data	H_1	H_2	Pooled data
S_1 (30–45 cm^2)	39.22	44.00	41.61	14.67	19.59	17.13
S_2 (45–45 cm^2)	36.78	40.56	38.67	15.59	17.75	16.67
S_3 (45–60 cm^2)	34.89	39.00	36.95	10.47	17.00	13.74
S_4 (60–60 cm^2)	33.11	37.33	35.22	9.72	15.67	12.70
Mean	36.00	40.22		12.61	17.50	
Factors	CD (p=0.05)			CD (p=0.05)		
Plant spacings	2.83			1.62		
Harvesting schedules	4.00			2.28		
Plant spacings×Harvesting schedules	NS			NS		

Table 5: Effect of different plant spacings and harvesting schedules on fresh and dry foliage weight plant^{-1} (g)

Parameters/ Treatments	Fresh foliage weight plant^{-1} (g)			Dry foliage weight plant^{-1} (g)		
	H_1	H_2	Pooled data	H_1	H_2	Pooled data
S_1 (30–45 cm^2)	81.55	94.67	88.11	31.64	41.88	36.76
S_2 (45–45 cm^2)	80.56	90.33	85.45	29.17	38.33	33.75
S_3 (45–60 cm^2)	67.78	84.11	75.94	20.11	33.10	26.60
S_4 (60–60 cm^2)	66.11	82.78	74.44	18.10	30.28	24.19
Mean	74.00	87.97		24.75	35.90	
Factors		CD (p=0.05)			CD (p=0.05)	
Plant spacings		2.74			2.58	
Harvesting Schedules		3.88			3.64	
Plant spacings×Harvesting schedules		NS			5.14	

Table 6: Effect of different plant spacings and harvesting schedules on estimated fresh and dry leaf yield (q ha^{-1})

Parameters/ Treatments	Estimated fresh leaf yield (q ha^{-1})			Estimated dry leaf yield (q ha^{-1})		
	H_1	H_2	Pooled data	H_1	H_2	Pooled data
S_1 (30–45 cm^2)	33.09	40.24	36.66	12.57	17.50	15.03
S_2 (45–45 cm^2)	18.10	24.28	21.19	5.98	9.53	7.75
S_3 (45–60 cm^2)	12.81	15.12	13.97	4.04	5.01	4.53
S_4 (60–60 cm^2)	8.24	9.01	8.63	2.42	2.95	2.68
Mean	18.06	22.16		6.25	8.75	
Factors		CD (p=0.05)			CD (p=0.05)	
Plant spacings		3.22			0.72	
Harvesting Schedules		4.56			1.01	
Plant spacings×Harvesting schedules		NS			1.43	

Table 7: Effect of different plant spacings and harvesting schedules on estimated fresh and dry foliage yield (q ha^{-1})

Parameters/ Treatments	Estimated fresh foliage yield (q ha^{-1})			Estimated dry foliage yield (q ha^{-1})		
	H_1	H_2	Pooled data	H_1	H_2	Pooled data
S_1 (30–45 cm^2)	60.41	70.12	65.27	23.43	31.02	27.23
S_2 (45–45 cm^2)	37.29	41.82	39.56	13.50	17.75	15.63
S_3 (45–60 cm^2)	23.53	29.21	26.37	6.98	11.49	9.24
S_4 (60–60 cm^2)	18.36	22.99	20.68	5.03	8.41	6.72
Mean	34.90	41.04		12.24	17.17	
Factors		CD (p=0.05)			CD (p=0.05)	
Plant spacings		1.58			1.37	
Harvesting schedules		2.23			1.93	
Plant spacings×Harvesting schedules		NS			2.17	

Table 8: Effect of different plant spacings and harvesting schedules on total leaf and foliage yield (q ha^{-1})

Parameters/ Treatments	Total leaf yield (q ha^{-1})		Total foliage yield (q ha^{-1})	
	Fresh yield	Dry yield	Fresh yield	Dry yield
S_1 (30–45 cm^2)	73.33	30.07	130.53	54.45
S_2 (45–45 cm^2)	42.38	15.51	79.11	31.25
S_3 (45–60 cm^2)	27.93	9.05	52.74	18.47
S_4 (60–60 cm^2)	17.26	5.37	41.35	13.44

of north-western Himalayas. Erik et al. (2018) reported that the highest density promoted higher yields per area in *Stevia rebaudiana*. Wanjari et al. (2017) also reported that narrow spacing recorded increased plant height and other growth characters in isabgol (*Plantago ovata*). Waghmare et al. (2018) also recorded the similar results in pigeon pea (*Cajanus cajan*). The present studies are also in line with Madisa et al. (2015) in okra (*Abelmoschus esculentus* L.). Katayama et al. (1976) in *Stevia rebaudiana*.

Maximum plant height, number of shoots, fresh leaf weight $plant^{-1}$, dry leaf weight $plant^{-1}$, fresh foliage weight $plant^{-1}$, dry foliage weight $plant^{-1}$, estimated fresh and dry foliage yield was observed in second harvesting (H_2: 70–80 days after first harvest) as compared to first harvesting (H_1: 50–60 days after transplanting). These findings are in line with the report of Kizil and Toncer (2006) in spearmint (*Mentha spicata*).

Table 9: Economics of cost of cultivation, gross return, net return and B:C ratio of *Stevia rebaudiana*

Plant spacings	Total cost of cultivation (₹ ha^{-1})	Total dry leaf yield (kg ha^{-1})	Average price ₹ kg^{-1}	Gross return (₹)	Net return (₹)	B:C ratio
S_1 (30–45 cm^2)	2,47,032.00	3,007	100	3,00,700.00	53,668.00	1.22
S_2 (45–45 cm^2)	2,41,019.00	1,551	100	1,55,100.00	-85,919.00	0.64
S_3 (45–60 cm^2)	2,28,776.00	905	100	90,500.00	-1,38,276.00	0.40
S_4 (60–60 cm^2)	2,21,430.00	537	100	53,700.00	-1,67,730.00	0.24

4. Conclusion

Stevia rebaudiana was found to be perennial shrub with height ranged from 35.17–95.00 cm. Maximum total fresh and dry leaf yield (73.33 q ha^{-1} and 30.07 q ha^{-1}), total fresh and dry foliage yield (130.53 q ha^{-1} and 54.45 q ha^{-1}) (Table 8) and B:C ratio (1.22) were observed at narrow spacing (45–30 cm^2) as compared to other spacings in two harvests. All the growth parameters were observed to be highest in two harvests in this spacing.

5. Acknowledgement

Authors are highly thankful to Vice chancellor of Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh, India to facilitate us during the research work.

6. References

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