



Performance of Different Varieties of Spinach Beet (*Beta vulgaris* var. *bengalensis*) under Prayagraj Agro-Climatic Condition

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was carried out at the Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, Uttar Pradesh during the Rabi 2021-2022 with a view to determine the performance of different varieties of spinach beet (*Beta vulgaris* var. *bengalensis*) for its growth, yield under Prayagraj climate and to work out the economics of various treatments. Under this experiment, overall 7 varieties were sown under tags T₁ (Pusa Jyoti), T₂ (All Green), T₃ (All Green H-1), T₄ (Green Iron), T₅ (Palak-Ashirwad), T₆ (Sudevi Green Spinach), T₇ (Supriya) which was laid out in randomized block design (RBD) with three replications. From the present investigation, it was concluded that variety Pusa Jyoti performed best in respect of all parameters specially yield (64.44q/ha) at Prayagraj climatic condition. The benefit-Cost ratio (1.61) of variety Pusa Jyoti was found to be the highest therefore, it can be suggested to farmers to adapt it in cultivation practices.

Keywords: Spinach beet; agro-climatic; varieties; benefit-cost ratio.

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1. INTRODUCTION

Spinach Beet or Palak (*Beta vulgaris var. bengalensis*) is one of the most popular leafy vegetables grown and consumed in India. Its tender soft succulent leaves are used as a vegetable. Being the cheapest source of calcium, iron, and phosphorus, it is valued much for its tender and soft leaves. Primary used as a potherb. It is native to the Indo-Chinese region. Belongs to the family Amaranthaceae and subfamily Chenopodiaceae with chromosome number $2n=2x=18$. Commonly known as Indian Palak or Desi palak or beet leaf. Leaves of this crop were first used in Bengal and hence known as *B. vulgaris var. bengalensis*. It can be differentiated on the basis of pigmentation of midrib and leaf veins as the cultivars of spinach beet are divided into two groups:-1) reddish midrib and leaf veins, 2) green midrib and leaf veins. It is closely related to beetroot, sugar beet, and Swiss chard. Sea beet (*Beta vulgaris var. maritima*) is the ancestor of palak [1]. Spinach beet needs well-balanced nutrition for better growth and yield. Manures are the substances which provide nutrients for proper growth of plants. Spinach plays a major role in human nutrition leaves contain 86.4% moisture, 3.4% protein, 0.8 g fat, 3.7% fibre, 6.5% carbohydrates, 46 calories, 5862 I.U vitamin A., 0.26 mg vitamin B1, 0.56 mg vitamin B2, 70 mg vitamin C, 380 mg calcium and 30 mg phosphorus. Spinach is a cool season crop. High temperature, especially long day cause bolting, thus reduces its market value. It thrives best in well drained loamy soil. pH should be in the range of 6-6.5. In 2018, world production of spinach was 26.3 million tonnes, with China alone accounting for 90% of the total followed by the U.S.A., Kenya, and Turkey. Spinach beet is widely grown in India. Few local varieties have gained importance in Uttar Pradesh climatic conditions. Varietal evaluation in a group of cultivars is a prerequisite for a successful breeding programme. Thus, study was done to evaluate the best performing varieties compared to local variety. According to Prayagraj agro-climatic condition Spinach beet can be grown successfully with higher yield. In view of the above-mentioned facts, the present study on the varietal evaluation of Spinach beet varieties under Prayagraj agro-climatic condition. Keeping these above point the present investigation was undertaken to assess the performance of different varieties of Spinach beet in terms of growth and yield under Prayagraj agro-climatic condition and to estimate the economics of different varieties.

2. MATERIAL AND METHODS

The experiment was conducted in Randomized Block Design comprising 7 varieties viz. T₁ (Pusa Jyoti), T₂ (All Green), T₃ (All Green H-1), T₄ (Green Iron), T₅ (Palak- Ashirwad), T₆ (Sudevi Green Spinach), T₇ (Supriya) with three replications during the year 2021-2022 at Horticultural Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj to understand the performance in terms of growth, the yield of different varieties of spinach beet [2]. The observations were recorded on randomly selected five plants on characters viz. Plant height [15, 30, 45 DAS], Number of leaves per plant [15, 30, 45 DAS], Leaf length [15, 30, 45 DAS], Leaf width [15, 30, 45 DAS], Yield per plant (g/plant), Yield per plot (kg/plot), Yield per hectare (q/ha). In general, the soil properties of the experimental site showed a typical alluvial soil of the eastern region of Uttar Pradesh. The soil was sandy loam in texture, slightly acidic in reaction and having low electrical conductivity, very high in organic carbon, low in available nitrogen, low in available phosphorus and moderately high in potassium. Weeding and plant protection measure were followed as and when needed. Observations were recorded at different stages of growth periods. Prayagraj is situated at an elevation of 78 meters above sea level at 25.45° North latitude and 81.84° East longitude. This region has a sub-tropical climate prevailing in the south-east part of U.P. with both the extremes in temperature, i.e. the winter and the summer. In cold winters, the temperature sometimes is as low as 76.6°F in December – January and very hot summer with temperature reaching upto 115°F in the months of May and June. During winter, frosts and during summer, hot scorching winds are also not uncommon. The average rainfall is around 332 (mm) with maximum concentration during July to September months with occasional showers in winters.

3. RESULTS AND DISCUSSION

In the present investigation an attempt has been made to study the performance of different spinach beet (*Beta vulgaris var. bengalensis*) varieties in Prayagraj climatic zone. The results obtained are presented in relevant Tables (Tables 1-6).

Plant height (cm): The results pertaining to the performance of different varieties of spinach beet

for plant height at 15, 30 and 45 DAS is shown in Table 1. The maximum plant height observed in T₁ (21.82 cm) at 15 DAS followed by T₅ (21.59 cm). Minimum plant height was observed in T₃ (13.00 cm). The maximum plant height (43.73 cm) at 30 DAS was observed with treatment T₁ (Pusa Jyoti) followed by T₅ (Palak-Ashirwad) with 38.73 cm. Minimum plant height 30.15 cm was observed in T₃ (All Green H-1). The maximum plant height (59.44 cm) at 45 DAS was observed with treatment T₁ (Pusa Jyoti) followed by T₅ (Palak-Ashirwad) with 54.55 cm. Minimum plant height 45.87 cm was observed in T₃ (All Green H-1), while the remaining treatments were moderate in their growth habit. Similar findings were reported by Ahmad et al. [3] in cucumber, Hossain et al. [4] in Indian spinach, Varalakshmi and Devaraju [5] in Indian spinach, Ali et al. [6] in onion, Dunsin et al. [7] in tomatoes, Malshe et al. [8] in okra, Sharma et al. [9] in beetroot, Karthick et al. [10] in ridge gourd, Mshelia and Muhammad [11] in okra, Singh et al. [12] in okra, Ddamulira et al. [13] in onion, Gul et al. [14] in cucumber, Ashraf et al. [15] in okra, Khadijeh et al. [16], Nath et al. [17] in spinach, in beetroot and Kurre et al. [18] in ridge gourd.

Leaf length (cm): The results pertaining to the performance of different varieties of spinach beet for leaf length at 15, 30, 45 DAS are graphically presented in Table 2.

The maximum leaf length (5.96 cm) at 15 DAS was observed with treatment T₁ (Pusa Jyoti) followed by T₇ (Supriya) with 5.56 cm. Minimum leaf length 4.85 cm was observed in T₂ (All Green). The maximum leaf length (9.87 cm) at 30 DAS was observed with treatment T₁ (Pusa Jyoti) followed by T₇ (Supriya) with 8.14cm. Minimum leaf length 7.03 cm was observed in T₂ (All Green). The maximum leaf length (12.96 cm) at 45 DAS was observed with treatment T₁ (Pusa Jyoti) followed by T₇ (Supriya) with 11.49 cm.

Minimum leaf length 11.26 cm was observed in T₂ (All Green). Similar findings were reported by Ahmad et al. [3] in cucumber, Hossain et al. [4] in Indian spinach, Varalakshmi and Devaraju [5] in Indian spinach, Ali et al. [6] in onion, Dunsin et al. [7] in tomatoes, Malshe et al. [8] in okra, Sharma et al. [9] in beetroot, Karthick et al. [10] in ridge gourd, Mshelia and Muhammad [11] in okra, Singh et al. [12] in okra, Ddamulira et al. [13] in onion, Gul et al. [14] in cucumber, Ashraf et al. [15] in okra, Khadijeh et al. [16], Nath et al. [17] in spinach, in beetroot and Kurre et al. [18] in ridge gourd.

Leaf width (cm): The results pertaining to the performance of different varieties of spinach beet for leaf width at 15, 30, 45 DAS are graphically presented in Table 3. The maximum leaf width (3.26 cm) at 15 DAS was observed with treatment T₁ (Pusa Jyoti) followed by T₅ (Palak-Ashirwad) with 2.62 cm. Minimum leaf width 1.76 cm was observed in T₃ (All Green H-1). The maximum leaf width (5.58 cm) at 30 DAS was observed with treatment T₁ (Pusa Jyoti) followed by T₅ (Palak-Ashirwad) with 5.12 cm. Minimum leaf width 3.72 cm was observed in T₂ (All Green). The maximum leaf width (7.57 cm) at 45 DAS was observed with treatment T₁ (Pusa Jyoti) followed by T₅ (Palak-Ashirwad) with 7.27 cm. Minimum leaf width 6.46 cm was observed in T₇ (Supriya). Similar findings were reported by Ahmad et al. [3] in cucumber, Hossain et al. [4] in Indian spinach, Varalakshmi and Devaraju [5] in Indian spinach, Ali et al. [6] in onion, Dunsin et al. [7] in tomatoes, Malshe et al. [8] in okra, Sharma et al. [9] in beetroot, Karthick et al. [10] in ridge gourd, Mshelia and Muhammad [11] in okra, Singh et al. [12] in okra, Ddamulira et al. [13] in onion, Gul et al. [14] in cucumber, Ashraf et al. [15] in okra, Khadijeh et al. [16], Nath et al. [17] in spinach, in beetroot and Kurre et al. [18] in ridge gourd.

Table 1. Plant height (cm) at 15, 30, 45 DAS of different varieties of spinach beet

Treatment notation	Varieties	15 DAS (in cm)	30 DAS (in cm)	45 DAS (in cm)
T ₁	Pusa Jyoti	21.82	43.73	59.44
T ₂	All Green	16.38	37.29	53.48
T ₃	All Green H-1	13.00	30.15	45.87
T ₄	Green Iron	16.09	31.95	48.29
T ₅	Palak-Ashirwad	21.59	38.73	54.55
T ₆	Sudevi Green Spinach	17.85	34.27	50.47
T ₇	Supriya	17.35	36.83	52.59
'F' Test		S	S	S
C.V.		10.21	7.48	7.80
S.E.± (m)		1.05	1.56	2.34
C.D. at 5%		3.22	4.81	7.22

Table 2. Leaf length (cm) 15 DAS, 30 DAS, 45 DAS of different varieties of Spinach beet

Treatment Notation	Varieties	15 DAS (in cm)	30 DAS (in cm)	45 DAS (in cm)
T ₁	Pusa Jyoti	5.96	9.87	12.96
T ₂	All Green	4.85	7.03	11.26
T ₃	All Green H-1	4.86	7.33	10.53
T ₄	Green Iron	5.25	7.69	10.05
T ₅	Palak-Ashirwad	5.03	8.12	10.75
T ₆	Sudevi Green Spinach	5.48	8.02	11.11
T ₇	Supriya	5.56	8.14	11.49
'F' Test		S	S	S
C.V.		4.62	6.24	7.97
S.E.± (m)		0.14	0.29	0.51
C.D. at 5%		0.43	0.89	1.58

Table 3. Leaf width (cm) 15 DAS, 30 DAS, 45 DAS of different varieties of Spinach beet

Treatment	15 DAS (in cm)	30 DAS (in cm)	45 DAS (in cm)
T ₁ (Pusa Jyoti)	3.26	5.58	7.57
T ₂ (All Green)	2.43	3.72	6.61
T ₃ (All Green H-1)	1.76	4.64	6.72
T ₄ (Green Iron)	2.38	4.98	6.67
T ₅ (Palak-Ashirwad)	2.62	5.12	7.27
T ₆ (Sudevi Green Spinach)	2.48	4.92	6.55
T ₇ (Supriya)	2.36	5.02	6.46
'F' Test	S	S	S
C.V.	9.04	5.90	5.92
S.E.± (m)	0.13	0.17	0.23
C.D. at 5%	0.40	0.51	0.72

Number of leaves per plant (No.): The results pertaining to the performance of different varieties of spinach beet for number of leaves per plant at 15, 30, 45 DAS are graphically presented in Table 4. The maximum number of leaves per plant (5.26) at 15 DAS was observed with treatment T₁ (Pusa Jyoti) followed by T₅ (Palak-Ashirwad) with 4.60. Minimum number of leaves per plant 3.33 was observed in T₄ (Green Iron). The maximum number of leaves per plant (7.80) at 30 DAS was observed with treatment T₁ (Pusa Jyoti) followed by T₅ (Palak-Ashirwad) with 7.40. Minimum number of leaves per plant 6.40 was observed in T₄ (Green Iron). The maximum number of leaves per plant (5.40) at 45 DAS was observed with treatment T₁ (Pusa Jyoti) followed by T₆ (Sudevi Green Spinach) with 5.36. Minimum number of leaves per plant 5.13 was observed in T₃ (All Green H-1). Similar findings were reported by Ahmad et al. [3] in cucumber, Hossain et al. [4] in Indian spinach, Varalakshmi and Devaraju [5] in Indian spinach, Ali et al. [6] in onion, Dunsin et al. [7] in tomatoes, Malshe et al. [8] in okra, Sharma et al. [9] in beetroot, Karthick et al. [10] in ridge gourd, Mshelia and Muhammad [11] in okra, Singh et al. [12] in okra, Ddamulira et al. [13] in onion, Gul et al. [14] in

cucumber, Ashraf et al. [15] in okra, Khadijeh et al. [16], Nath et al. [17] in spinach, in beetroot and Kurre et al. [18] in ridge gourd.

Yield per plant (g/plant), Yield per plot (Kg/plot), Yield per hectare (q/ha): The results pertaining to the performance of different varieties of spinach beet for yield per plant are graphically presented in Table 5. The fresh leaves weight or yield per plant significantly varied among different treatment combinations. The maximum yield per plant (37.92 g/plant) was observed with treatment T₁ (Pusa Jyoti) followed by T₇ (Supriya) with 32.19 g/plant. Minimum yield per plant 23.47 g/plant was observed in T₃ (All Green H-1). The maximum yield per plot (2.90 kg/plot) was observed with treatment T₁ (Pusa Jyoti) followed by T₅ (Palak-Ashirwad) with 2.58 kg/plot. Minimum yield per plot 50.59 Kg/plot was observed in T₃ (All Green H-1). The maximum yield per hectare (64.44 q/ha) was observed with treatment T₁ (Pusa Jyoti) followed by T₅ (Palak-Ashirwad) with 57.41 q/ha. Minimum yield per hectare 50.59 q/ha was observed in T₃ (All Green H-1). Similar findings were reported by Ahmad et al. [3] in cucumber, Hossain et al. [4] in Indian spinach, Varalakshmi and Devaraju [5] in

Indian spinach, Ali et al. [6] in onion, Dunsin et al. [7] in tomatoes, Malshe et al. [8] in okra, Sharma et al. [9] in beetroot, Karthick et al. [10] in ridge gourd, Mshelia and Muhammad [11] in okra, Singh et al. [12] in okra, Ddamulira et al. [13] in onion, Gul et al. [14] in cucumber, Ashraf et al. [15] in okra, Khadijeh et al. [16], Nath et al. [17] in spinach, in beetroot and Kurre et al. [18] in ridge gourd.

Economic Parameter: Maximum gross returns were recorded in treatment T₁ (Pusa Jyoti) with (Rs 1,61,100 ha⁻¹) followed by T₅ (Palak-

Ashirwad) with (Rs 1,43,525 ha⁻¹) and the minimum (Rs. 1,26,475 ha⁻¹) was recorded in treatment T₃ (All Green H-1). Maximum net returns were recorded in treatment T₁ (Pusa Jyoti) with (Rs 99,379 ha⁻¹) followed by T₅ (Palak-Ashirwad) with (Rs 81,769 ha⁻¹) and the minimum (Rs. 64,629 ha⁻¹) was recorded in treatment T₃ (All Green H-1). Maximum benefit: cost ratio was recorded in T₁ (Pusa Jyoti) with (1.61) followed by T₅ (Palak-Ashirwad) with (1.32) and the minimum (1.04) was recorded in treatment T₃ (All Green H-1). The detail is presented in Table 6.

Table 4. Number of leaves per plant 15 DAS, 30 DAS, 45 DAS of different Varieties of Spinach beet

Treatment Notation	Varieties	15 DAS	30 DAS	45 DAS
T ₁	Pusa Jyoti	5.26	7.80	5.40
T ₂	All Green	3.66	6.66	5.14
T ₃	All Green H-1	4.46	6.80	5.13
T ₄	Green Iron	3.33	6.40	5.34
T ₅	Palak-Ashirwad	4.60	7.40	5.40
T ₆	Sudevi Green Spinach	4.40	6.86	5.36
T ₇	Supriya	3.73	7.00	5.33
'F' Test		S	S	S
C.V.		8.39	6.57	6.05
S.E.± (m)		0.20	0.27	0.35
C.D. at 5%		0.63	0.82	0.48

Table 5. Yield per plant, yield per plot and yield per hectare of different Varieties of Spinach beet

Treatment Notation	Varieties	Yield per plant (g/plant)	Yield per plot (kg/plot)	Yield per hectare (q/ha)
T ₁	Pusa Jyoti	37.92	2.90	64.44
T ₂	All Green	30.73	2.42	53.77
T ₃	All Green H-1	23.47	2.27	50.59
T ₄	Green Iron	31.44	2.51	55.70
T ₅	Palak-Ashirwad	27.06	2.58	57.41
T ₆	Sudevi Green Spinach	26.87	2.30	51.11
T ₇	Supriya	32.19	2.30	51.18
'F' Test		S	S	S
C.V.		4.50	4.89	8.98
S.E.± (m)		1.45	0.07	2.84
C.D. at 5%		8.36	0.22	8.77

Table 6. Performance of Spinach Beet in terms of Economics –Benefit Cost Ratio of various treatments

Treatment	Yield (q/ha)	Gross Return (in ₹)	Net return (in ₹)	B:C Ratio	
T ₁	Pusa Jyoti	64.44	1,61,100	99,379	1.61
T ₂	All Green	53.77	1,34,425	72,654	1.18
T ₃	All Green H-1	50.59	1,26,475	64,629	1.04
T ₄	Green Iron	55.70	1,39,250	77,514	1.26
T ₅	Palak-Ashirwad	57.41	1,43,525	81,769	1.32
T ₆	Sudevi Green Spinach	51.11	1,27,775	65,954	1.07
T ₇	Supriya	51.18	1,27,950	66,094	1.07

4. CONCLUSION

From the present investigation, it was concluded that Spinach beet (*Beta vulgaris* var. *bengalensis*) variety Pusa Jyoti performed best in respect of all parameters specially yield at Prayagraj climatic conditions. Benefit Cost ratio of variety Pusa Jyoti was found to be the highest therefore, it can be suggested to farmers to adapt it in cultivation practices.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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