Performance of different varieties of Spinach beet (*Beta vulgaris* var. *bengalensis*) under Prayagraj Agro-Climatic condition

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 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 T_1 (Pusa Jyoti), T_2 (All Green), T_3 (All Green H-1), T_4 (Green Iron), T_5 (Palak- Ashirwad), T_6 (Sudevi Green Spinach), T_7 (Supriya). From the present investigation it was concluded that 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 highest therefore, it can be suggested to farmers to adapt it in cultivation practices.

Keywords: *Spinach beet, Agro-Climatic, Varieties, Benefit Cost ratio.*

INTRODUCTION

Spinach Beetroot (*Beta vulgaris var. bengalensis*) is a leafy green flowering plant native to Indo-china region (Nath, 1976). It belongs to family *Amaranthaceae*, subfamily Chenopodioideae bearing chromosome number 2n=2X=18 (Bennett and Smith, 1976). Its leaves are a common edible vegetable consumed either fresh, or after storage using preservation techniques by canning, freezing, or dehydration. It may be eaten cooked or raw, and the taste differs considerably; the high oxalate content may be reduced by steaming. It is closely related to beet root, sugar beet, and Swiss chard. Sea beet (*Beta vulgaris* var. maritima) is the ancestor of *palak*. It is commonly grown for its tender and soft succulent leaves. Spinach beet needs a 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 calorie, 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 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 conditions and to estimate the economics of different varieties.

MATERIAL AND METHODS

A field experiment was conducted in Randomized Block Design comprising 7 varieties (detail of varieties presented in table 1) with three replications during *Rabi-2021* 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, yield of different varieties of spinach beet. 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, soil properties of experimental site showed a typical alluvial soil of eastern region of Uttar Pradesh. 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 available potassium given in table 2 and 3. Weeding and plant protection measure were followed as and when needed. Observations were recorded at different stages of growth periods. The data were statistically analysed by the method suggested by **Fisher and Yates, 1936.**

Table 1. List of varieties used as treatments

Treatment Symbols	Varieties name/ Treatments
T_1	Pusa Jyoti
T_2	All Green
T_3	All Green H-1
T_4	Green Iron
T_5	Palak-Ashirwad
T_6	Sudevi Green Spinach
T_7	Supriya

Table 2. Physical and chemical properties of soil at Horticulture Research field (SHUATS).

S. No.	Particulars	Mechanical Properties
1	Sand	48.15
2	Silt	21.34
3	Clay	30.51
4	Textural class	Sandy loam

Table 3. Chemical composition of the soil

S. No.	Ingredients	Quantity	Methods used
1	Soil pH	6.9	Digital pH meter (M.LJackon)
2	Organic carbon (%)	0.358	Wet method **(Walkely and Black' 1965)**
3	Available Nitrogen (N)	212.56 kg/ha	Alkaline permanganate method **(Subaiah & Asijal 1956)**
4	Available Phosphorus (P)	14.59 kg/ha	Calorimetric method **(Olson *et al.*, 1954)**
5	Available Potash (K)	225.1 kg/ha	Flame Photometric method **(Peru *et al.* 1973)**

Source: Soil analysis was done by KVK (Krishi Vigyan Kendra, Prayagraj, U.P.)

RESULTS AND DISCUSSION

In the present investigation an attempt has been made to study the performance of different spinach beet varieties in Prayagraj climatic zone. The results obtained are presented in relevant Tables as follows;

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 4. The maximum plant height observed in T_1 (21.82 cm) at 15 DAS followed by T_5 (21.59 cm). Minimum plant height was observed in T_3 (13.00 cm). The maximum plant height (43.73 cm) at 30 DAS was observed with treatment T_1 (Pusa Jyoti) followed by T_5 (Palak-Ashirwad) with 38.73 cm. Minimum plant height 30.15 cm was observed in T_3 (All Green H-1). The maximum plant height (59.44 cm) at 45 DAS was observed with treatment T_1 (Pusa Jyoti) followed by T_5 (Palak-Ashirwad) with 54.55 cm.

Minimum plant height 45.87 cm was observed in T_3 (All Green H-1), while the remaining treatments were moderate in their growth habit. Similar findings were reported by **Ahmad *et al.* (2004)** in cucumber, **Hossain *et al.* (2005)** in indian spinach, **Varalaxmi and Devaraju (2010)** in indian spinach, **Ali *et al.* (2014)** in onion, **Dunsin *et al.* (2015)** in tomatoes, **Malshe *et al.* (2016)** in okra, **Sharma *et al.* (2016)** in beetroot, **Karthick *et al.* (2017)** in ridge gourd, **Mshelia *et al.* (2018)** in okra, **Singh *et al.* (2018)** in okra, **Ddamulira *et al.* (2019)** in onion, **Gul *et al.* (2019)** in cucumber, **Ashraf *et al.* (2020)** in okra, **Khadijeh *et al.* (2020), Nath *et al.* (2020)** in spinach, in beetroot and **Kurre *et al.* (2022)** in ridge gourd.

Table 4. 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
Mean		**17.73**	**36.14**	**52.10**
'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**

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 5.

The maximum leaf length (5.96 cm) at 15 DAS was observed with treatment T_1 (Pusa Jyoti) followed by T_7 (Supriya) with 5.56 cm. Minimum leaf length 4.85 cm was observed in T_2 (All Green). The maximum leaf length (9.87 cm) at 30 DAS was observed with treatment T_1 (Pusa Jyoti) followed by T_7 (Supriya) with 8.14cm. Minimum leaf length 7.03 cm was observed in T_2 (All Green). The maximum leaf length (12.96 cm) at 45 DAS was observed with treatment T_1 (Pusa Jyoti) followed by T_7 (Supriya) with 11.49 cm. Minimum leaf length 11.26 cm was observed in T_2 (All Green). Similar findings were reported by **Ahmad *et al.* (2004)** in cucumber, **Hossain *et al.* (2005)** in indian spinach, **Varalaxmi and Devaraju (2010)** in indian spinach, **Ali *et al.* (2014)** in onion, **Dunsin *et al.* (2015)** in tomatoes, **Malshe *et al.* (2016)** in okra, **Sharma *et al.* (2016)** in beetroot, **Karthick *et al.* (2017)** in ridge gourd, **Mshelia *et al.* (2018)** in okra, **Singh *et al.* (2018)** in okra, **Ddamulira *et al.* (2019)** in onion, **Gul *et al.* (2019)** in cucumber, **Ashraf *et al.* (2020)** in okra, **Khadijeh *et al.* (2020), Nath *et al.* (2020)** in spinach, in beetroot and **Kurre *et al.* (2022)** in ridge gourd.

Table 5 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
Mean		**5.29**	**8.03**	**11.17**
'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**

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 6. The maximum leaf width (3.26 cm) at 15 DAS was observed with treatment T_1 (Pusa Jyoti) followed by T_5 (Palak-Ashirwad) with 2.62 cm. Minimum leaf width 1.76 cm was observed in T_3 (All Green H-1). The maximum leaf width (5.58 cm) at 30 DAS was observed with treatment T_1 (Pusa Jyoti) followed by T_5 (Palak-Ashirwad) with 5.12 cm. Minimum leaf width 3.72 cm was observed in T_2 (All Green). The maximum leaf width (7.57 cm) at 45 DAS was observed with treatment T_1 (Pusa Jyoti) followed by T_5 (Palak-Ashirwad) with 7.27 cm. Minimum leaf width 6.46 cm was

observed in T_7 (Supriya). Similar findings were reported by **Ahmad *et al.* (2004)** in cucumber, **Hossain *et al.* (2005)** in indian spinach, **Varalaxmi and Devaraju (2010)** in indian spinach, **Ali *et al.* (2014)** in onion, **Dunsin *et al.* (2015)** in tomatoes, **Malshe *et al.* (2016)** in okra, **Sharma *et al.* (2016)** in beetroot, **Karthick *et al.* (2017)** in ridge gourd, **Mshelia *et al.* (2018)** in okra, **Singh *et al.* (2018)** in okra, **Ddamulira *et al.* (2019)** in onion, **Gul *et al.* (2019)** in cucumber, **Ashraf *et al.* (2020)** in okra, **Khadijeh *et al.* (2020), Nath *et al.* (2020)** in spinach, in beetroot and **Kurre *et al.* (2022)** in ridge gourd.

Table 6: 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
Mean	**2.47**	**4.86**	**6.84**
'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 7. The maximum number of leaves per plant (5.26) at 15 DAS was observed with treatment T_1 (Pusa Jyoti) followed by T_5 (Palak-Ashirwad) with 4.60. Minimum number of leaves per plant 3.33 was observed in T_4 (Green Iron). The maximum number of leaves per plant (7.80) at 30 DAS was observed with treatment T_1 (Pusa Jyoti) followed by T_5 (Palak-Ashirwad) with 7.40. Minimum number of leaves per plant 6.40 was observed in T_4 (Green Iron). The maximum number of leaves per plant (5.40) at 45 DAS was observed with treatment T_1 (Pusa Jyoti) followed by T_6 (Sudevi Green Spinach) with 5.36. Minimum number of leaves per plant 5.13 was observed in T_3 (All Green H-1). Similar findings were reported by **Ahmad *et al.* (2004)** in cucumber, **Hossain *et al.* (2005)** in indian spinach, **Varalaxmi and Devaraju (2010)** in indian spinach, **Ali *et al.* (2014)** in onion, **Dunsin *et al.* (2015)** in tomatoes, **Malshe *et al.* (2016)** in okra, **Sharma *et al.* (2016)** in beetroot, **Karthick *et al.* (2017)** in ridge gourd, **Mshelia *et al.* (2018)** in okra, **Singh *et al.* (2018)** in okra, **Ddamulira *et al.* (2019)** in onion, **Gul *et al.* (2019)** in cucumber, **Ashraf *et al.* (2020)** in okra, **Khadijeh *et al.* (2020), Nath *et al.* (2020)** in spinach, in beetroot and **Kurre *et al.* (2022)** in ridge gourd.

Table 7. 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
Mean		**4.21**	**6.99**	**5.27**
'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**

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 8. 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 T_1 (Pusa Jyoti) followed by T_7 (Supriya) with 32.19 g/plant. Minimum yield per plant 23.47 g/plant was observed in T_3 (All Green H-1). The maximum yield per plot (2.90 kg/plot) was observed with treatment T_1 (Pusa Jyoti) followed by T_5 (Palak-Ashirwad) with 2.58 kg/plot. Minimum yield per plot 50.59 Kg/plot

was observed in T_3 (All Green H-1). The maximum yield per hectare (64.44 q/ha) was observed with treatment T_1 (Pusa Jyoti) followed by T_5 (Palak-Ashirwad) with 57.41 q/ha. Minimum yield per hectare 50.59 q/ha was observed in T_3 (All Green H-1). Similar findings were reported by **Ahmad *et al.* (2004)** in cucumber, **Hossain *et al.* (2005)** in indian spinach, **Varalaxmi and Devaraju (2010)** in indian spinach, **Ali *et al.* (2014)** in onion, **Dunsin *et al.* (2015)** in tomatoes, **Malshe *et al.* (2016)** in okra, **Sharma *et al.* (2016)** in beetroot, **Karthick *et al.* (2017)** in ridge gourd, **Mshelia *et al.* (2018)** in okra, **Singh *et al.* (2018)** in okra, **Ddamulira *et al.* (2019)** in onion, **Gul *et al.* (2019)** in cucumber, **Ashraf *et al.* (2020)** in okra, **Khadijeh *et al.* (2020), Nath *et al.* (2020)** in spinach, in beetroot and **Kurre *et al.* (2022)** in ridge gourd.

Table 8. 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
Mean		29.95	2.47	54.89

'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

Economic Parameter

Maximum gross returns were recorded in treatment T_1 (Pusa Jyoti) with (Rs 1,61,100 ha^{-1}) followed by T_5 (Palak-Ashirwad) with (Rs 1,43,525 ha^{-1}) and the minimum (Rs. 1,26,475 ha^{-1}) was recorded in treatment T_3 (All Green H-1). Maximum net returns were recorded in treatment T_1 (Pusa Jyoti) with (Rs 99,379 ha^{-1}) followed by T_5 (Palak-Ashirwad) with (Rs 81,769 ha^{-1}) and the minimum (Rs. 64,629 ha^{-1}) was recorded in treatment T_3 (All Green H-1). Maximum benefit: cost ratio was recorded in T_1 (Pusa Jyoti) with (1.61) followed by T_5 (Palak-Ashirwad) with (1.32) and the minimum (1.04) was recorded in treatment T_3 (All Green H-1). The detail is presented in table 9.

Table 9. Performance of in terms of Economics – Cost Benefit ratio of various treatments of Spinach Beet

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**

CONCLUSION

From the present investigation it was concluded that 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 highest therefore, it can be suggested to farmers to adapt it in cultivation practices.

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