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Effect of spacing and organic manure on yield and quality of Indian spinach (*Basella rubra* L.)

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Abstract

Basella (*Basella rubra*), commonly known as Ceylon spinach, Malabar spinach, Indian spinach, or vine spinach, is a climbing perennial plant that is sometimes grown as an annual vegetable. It is a resilient plant with the ability to withstand the high rainfall typical of the Konkan region, a condition that no other leafy vegetable can tolerate, especially between June and September. Despite its potential, *Basella* has remained underutilized due to the lack of standardized production practices. Experimental results showed that the combination of treatment S3M1 (50 × 60 cm spacing and FYM at 10 t/ha plus 100:50:50 kg/ha NPK) resulted in the highest total herbage yield per plant and dry matter content, while the S3M3 treatment (50 × 60 cm spacing with poultry manure at 4 t/ha) yielded the best shelf life.

Keywords: *Basella rubra*, Malabar spinach, spacing and nutrient management, herbage yield, shelf life

Introduction

Basella (*Basella rubra*), also known as Ceylon spinach, Malabar spinach, Indian spinach, or vine spinach, is a fast-growing, climbing perennial plant that can be grown as an annual vegetable. It has succulent vines with tender leaves and can grow up to 10 meters long when supported by a trellis. The plant features purplish-red stems and petioles, contrasting with thick, glossy, heart-shaped green leaves. *Basella* produces small pink or white flowers that mature into dark purple or black berry-like fruits. It is rich in calcium, iron, and vitamins A and C, containing higher levels of these nutrients compared to many traditional leafy greens (Palada *et al.*, 1999)^[4]. *Basella* thrives in tropical, hot, and humid climates with temperatures between 21°C and 35°C and is sensitive to frost, halting growth when temperatures fall below 10-14°C. During June to September, no other leafy vegetable can be cultivated, either commercially or in home gardens, in the region. This study on Indian spinach was conducted at the College of Horticulture, Dapoli, Ratnagiri, during both the summer and kharif seasons.

Material and Methods

A field experiment was conducted at the College of Horticulture, Dapoli, Ratnagiri, during the rabi season. The experiment followed a split-plot design with three replications and 12 treatment combinations. The treatments included three different spacing configurations: S1 (50 × 30 cm), S2 (50 × 45 cm), and S3 (50 × 60 cm) as main plot treatments, and four types of organic manure as sub-plot treatments: M1 (FYM @ 10 t/ha + 100:50:50 kg/ha NPK), M2 (vermicompost @ 5 t/ha), M3 (poultry manure @ 4 t/ha), and M4 (Neem cake @ 2 t/ha). The experimental beds (3.6 m × 2.5 m) were prepared, and the necessary fertilizers were applied according to the respective treatments. After planting the seeds at the specified spacings, intercultural operations such as weeding and irrigation were carried out to ensure optimal growth. Growth and yield parameters were recorded, and the data was analyzed using standard methods (Panse and Sukhatme, 1995)^[5].

Results and Discussion

Total Herbage Yield per Plant (g)

The data revealed significant variation in total herbage yield per plant based on different spacing treatments. The highest yield (406.23 g) was achieved with treatment S3, followed

by S2 (403.18 g), while the lowest yield (394.56 g) was observed in S1. The higher yield in S3 may be attributed to the increased space allowing for better nutrient uptake, aeration, and sunlight exposure, leading to enhanced photosynthesis, maximum growth, and greater foliage coverage. Similar results were found by Mane *et al.* (2008) in spinach [2].

The highest herbage yield (404.58 g) was observed with treatment M1 (FYM @ 10 t/ha + 100:50:50 kg/ha NPK), followed by M3 (402.97 g). The lowest yield (397.73 g) was

recorded with treatment M4 (neem cake @ 2 t/ha), in line with findings from Padmanabha *et al.* (2009) in palak and Hashimi *et al.* (2019) in spinach [1, 3].

When combining spacing and organic manure, the highest total herbage yield (409.23 g) was recorded with treatment S3M1, followed closely by S3M3 (408.02 g). The lowest yield (391.18 g) was observed in S1M4. The increased yield in S3M1 can be explained by the ample opportunity for the plant to access nutrients, air, and sunlight, resulting in optimal photosynthesis and growth.

Table 1: Effect of spacing and organic manure on total herbage yield per plant of Indian spinach

Treatment	Total herbage yield per plant (g/plant)			
	S ₁	S ₂	S ₃	Mean
M ₁	397.66	406.84	409.23	404.58
M ₂	393.50	401.82	404.72	400.01
M ₃	395.92	404.99	408.02	402.97
M ₄	391.18	399.08	402.94	397.73
Mean	394.56	403.18	406.23	
	S		M	S × M
F test	Sig		Sig	Sig
S.E.m.±	0.009		0.012	0.035
CD @ 5%	0.026		0.035	0.104

4.3. Quality parameters

Vitamin A content (mg/100 g)

β-Carotene, a precursor of vitamin A, is an important quality parameter in Indian spinach. The data on β-carotene content are summarized in the table below.

The effect of spacing on vitamin A content in Indian spinach showed no significant variation, with levels ranging from 3.54 mg to 3.69 mg. The highest vitamin A content (3.71 mg/100 g) was recorded in treatment M1, which was statistically similar to M3 (3.69 mg/100 g) and M4 (3.65 mg/100 g). The lowest vitamin A content (3.35 mg/100 g) was observed in treatment M2. The data also indicated that there was no significant variation in vitamin A content when considering the interaction between spacing and organic manure treatments.

4.3.4. Ascorbic acid content (mg/100g)

The data on the variation in ascorbic acid content in Indian spinach, influenced by different spacing, organic manure treatments, and their interactions, are presented in the table below.

Ascorbic acid content showed no significant variation with respect to spacing, with levels ranging from 66.34 mg to 66.47 mg. Spacing had no noticeable effect on the ascorbic acid content. However, the content of ascorbic acid was significantly affected by the type of organic manure used. The highest ascorbic acid content (68.67 mg/100 g) was observed in treatment M3, while the lowest (62.93 mg/100 g) was recorded with treatment M2. The interaction between spacing and organic manure had no significant effect on the ascorbic acid content of Indian spinach.

Table 2: Effect of spacing and organic manure on vitamin A and ascorbic acid content of Indian spinach

Treatment	Vitamin A (mg/100 g)				Ascorbic acid (mg/100g)			
	S ₁	S ₂	S ₃	Mean	S ₁	S ₂	S ₃	Mean
M ₁	3.68	3.71	3.73	3.71	67.31	67.30	67.35	67.32
M ₂	3.16	3.22	3.66	3.35	62.79	62.82	63.17	62.93
M ₃	3.66	3.69	3.71	3.69	68.64	68.66	68.71	68.67
M ₄	3.65	3.66	3.65	3.65	66.61	66.64	66.64	66.63
Mean	3.54	3.57	3.69		66.34	66.36	66.47	
	S		M	S × M	S		M	S × M
F test	NS		Sig	NS	NS		Sig	NS
S.E.m.±	0.02		0.03	0.09	0.01		0.02	0.05
CD @ 5%	--		0.09	--	--		0.06	--

4.3.5 Dry matter (%): The data on dry matter content revealed significant variation based on spacing. The highest dry matter content (14.81%) was recorded with treatment S3, which was significantly higher than the other spacings. In contrast, the lowest dry matter content (11.77%) was found with treatment S1. This could be attributed to the fact that wider spacing allows the plant to receive more light and nutrients, promoting better nutrient assimilation and resulting in higher dry matter content.

The data also showed that different organic manure treatments had a significant impact on the dry matter content

of Indian spinach. The highest dry matter content (14.88%) was recorded with treatment M1, while the lowest (11.28%) was observed with treatment M4. This demonstrates that organic manure significantly influences the dry matter content, with M1 yielding the highest and M4 the lowest values. These findings are consistent with results reported by Padmanabha *et al.* (2009) in palak [3].

Among the various treatment combinations, significant differences in dry matter content were observed. The highest dry matter (16.42%) was recorded with the combination of S3M1, while the lowest dry matter (9.36%) was observed in

the combination of S1M4. This suggests that the favorable combination of wider spacing (S3) and organic manure (M1) contributed to the highest dry matter content in Indian spinach.

4.3.6 Shelf life (hrs.)

The data on shelf life revealed significant variation based on spacing. The longest shelf life (33.58 hours) was recorded with treatment S3, which was significantly better than the other spacings. In contrast, the shortest shelf life (29.50 hours) was observed with treatment S1.

Different organic manure treatments also had a significant effect on the shelf life of Indian spinach. The highest shelf life (33.33 hours) was recorded with treatment M3, while the lowest (30.33 hours) was noted with treatment M4.

When considering the various treatment combinations, significant differences in shelf life were observed. The longest shelf life (36.00 hours) was recorded with the combination of S3M3, while the shortest shelf life (28.00 hours) was recorded with the combination of S1M4. This suggests that the favorable combination of wider spacing (S3) and poultry manure (M3) contributed to the longest shelf life of Indian spinach.

Table 3: Effect of spacing and organic manure on dry matter and shelf life of Indian spinach

Treatment	Dry matter (%)				Shelf life (hrs.)			
	S ₁	S ₂	S ₃	Mean	S ₁	S ₂	S ₃	Mean
M ₁	13.89	14.34	16.42	14.88	30.00	30.00	32.33	30.78
M ₂	11.52	13.42	14.19	13.04	29.00	32.00	32.00	31.00
M ₃	12.32	13.65	15.83	13.93	31.00	33.00	36.00	33.33
M ₄	9.36	11.67	12.81	11.28	28.00	29.00	34.00	30.33
Mean	11.77	13.27	14.81		29.50	31.00	33.58	
	S		M	S × M	S		M	S × M
F test	Sig		Sig	Sig	Sig		Sig	Sig
S.E.m.±	0.0006		0.0008	0.002	0.03		0.04	0.11
CD @ 5%	0.0018		0.0024	0.007	0.08		0.11	0.33

Conclusion

The results indicated that treatment S3 (50 × 60 cm spacing) was the most profitable in terms of spacing, while for higher yield, the organic manure combination of FYM @ 10 t/ha + 100:50:50 kg/ha NPK (treatment M1) was economically the best. Considering the interaction between spacing and organic manure, the combination of S1M1 (50 × 30 cm spacing with FYM @ 10 t/ha + 100:50:50 kg/ha NPK) was the most profitable for achieving higher yield. However, the highest shelf life of the produce was observed in the treatment combination S3M3. Additionally, the highest vitamin A content (3.71 mg/100 g) was recorded with treatment M1.

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