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

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Abstract

An investigation was carried out at the College of Horticulture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri (MS) during the period *kharif* and *summer* season to study the effect of spacing and organic manure on growth and yield performances of Indian spinach. The study was conducted with three different spacing *viz.*, The treatments comprised of the combination of three different spacing *viz.*, S₁ (50 × 30 cm), S₂ (50 × 45 cm) and S₃ (50 × 60 cm) as main plot treatments and b) organic manure treatments *viz.*, 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) as sub-plot treatments. The S₂ *i.e.*, 50 × 45 cm was performed better and found significantly superior over other spacing treatments in respect of number of leaves and number of branches. However, plant height and stem diameter was found significantly superior in S₃ *i.e.*, spacing 50 × 60 cm. In respect of organic manure, the organic manure M₁ *i.e.*, FYM @ 10 t/ha + 100:50:50 kg/ha NPK was found significantly superior in plant height, stem diameter, number of leaves, number of branches and yield per hectare. In respect of interaction of spacing and organic manure, the treatment combination S₃M₁ was found significantly superior in plant height and stem diameter maximum while, number of leaves and number of branches was highest in treatment combination S₂M₁. However, the herbage yield per hectare was found in treatment combination S₁M₁. Hence, the treatment S₁M₁ (50 × 30 cm spacing with FYM @ 10 t/ha + 100:50:50 kg/ha NPK) was found to be most profitable.

Keywords: Indian spinach, spacing, organic manure, growth and yield

Introduction

Indian spinach (*Basella rubra* L.) commonly known as poi, mayalu, belongs to the family Basellaceae which is also popular as summer leafy vegetable. It is also known as Malabar, Ceylon, East-Indian, Surinam and Chinese spinach (Facciola, 1990) [3]. Indian spinach is a fleshy, twining much branched herb with alternate leaves. Leaves are broadly ovate and pointed at the apex. Flowers are white or pink, small sessile in cluster on elongated thickened peduncles in an open branched inflorescence. Fruit is enclosed in fleshy perianth. It is fast growing perennial plant, however, cultivated as an annual for home gardens and as a cash crop to some extent. It is an easy growing plant propagated by seed, root or long tip cuttings. *B. rubra* is commonly grown for its leaves and young shoots, which are high in Vitamin A, B₉, C, iron and calcium (Grubben and Denton, 2004) [4].

The protocol required for its commercial cultivation *viz.* spacing, manures and fertilizers etc. have not yet been studied. Hence, considering the importance of these aspects the present investigation was taken on Indian spinach at College of Horticulture, Dapoli, Ratnagiri (Dist.) during the summer and kharif season to determine optimum spacing and suitable organic manure in order to have maximum vegetative growth and higher yield.

Materials and Methods

A field experiment was conducted at Experimental field of College of Horticulture, Dapoli. Dist. Ratnagiri during rabi season. The experiment was designed to study the effect of spacing and organic manure on growth and yield performances of Indian spinach. The experiment was laid out in a split plot design with three replications having 12 treatment combinations. The treatments comprised of the combination of three different spacing *viz.*, S₁ (50 × 30 cm), S₂ (50 × 45 cm) and S₃ (50 × 60 cm) as main plot treatments and b) organic manure treatments *viz.*, 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) as sub-plot treatments.

Seeds were sown at different spacing as per the treatments *i.e.* in S₁ plot (50 × 30 cm), S₂ plot (50 × 30 cm) and S₃ plot (50 × 30 cm). After emergence of seedling, other intercultural operations like weeding, irrigation were followed as per recommendation for better growth and development of the plant. The observations were recorded on growth and yield parameters and data was analysed by using the standard methods as described by Panse and Sukhatme (1995) [9].

Results and Discussion

Table 1: Effect of spacing and organic manure on plant height and stem diameter of Indian spinach

Treatments	Plant height (cm)				Stem diameter (mm)			
	S ₁	S ₂	S ₃	Mean	S ₁	S ₂	S ₃	Mean
M ₁	48.31	50.27	53.35	50.64	15.31	17.73	19.86	17.63
M ₂	47.34	47.51	49.52	48.12	13.55	14.60	15.64	14.60
M ₃	48.45	48.63	52.90	49.99	14.77	16.40	16.71	15.96
M ₄	46.26	46.32	48.43	47.00	12.44	13.62	14.92	13.66
Mean	47.59	48.18	51.05		14.02	15.59	16.78	
	S	M	S × M		S	M	S × M	
F-test	Sig	Sig	Sig		Sig	Sig	Sig	
S.E.m ±	0.015	0.02	0.06		0.0028	0.004	0.011	
CD at 5%	0.043	0.06	0.17		0.0081	0.011	0.033	

Plant height (cm)

The effect of spacing on the plant height of Indian spinach was found to be significant. The treatment S₃ (51.05 cm) recorded significantly highest plant height whereas, the lowest plant height was recorded in S₁ (47.59 cm). The highest plant height with wider spacing might be due to low plant population per unit area which resulted in optimum space available for proper plant growth as well as availability of nutrients, light, soil moisture and aeration available for plant growth. The similar results were also reported by Rashid *et al.* (1981) in kangkong, Ahbasdokht *et al.* (2003) [1] in amaranth, Bairagi (2014) [2] in fenugreek and Islam *et al.* (2014) [6] in Indian spinach. A significant variation was observed on plant height in organic manure. The highest plant height was recorded in M₁ (50.64 cm) followed by M₃ (49.99 cm) whereas, the lowest plant height was recorded in M₄ (47.00 cm). The highest plant height was recorded in M₁ might be due to higher availability of nitrogen, phosphorus and potassium to the plants initially through inorganic fertilizers and through FYM fulfilling the needs of plant throughout the cropping season. The interaction effect on plant height was found to be significant. The highest plant height of Indian spinach was recorded in S₃M₁ (53.35 cm) whereas, the lowest was recorded in S₁M₄ (46.26 cm) which was at par with S₂M₄ (46.32 cm). The highest plant height was found with treatment combinations S₃M₁ (50 × 60 cm along with FYM @ 10 t/ha + 100: 50: 50 kg/ha NPK) might be due to favourable combination effect of higher spacing along with inorganic fertilizer and FYM.

Stem diameter (mm)

The treatment S₃ (16.78 mm) recorded significantly highest stem diameter whereas, the lowest stem diameter was recorded in S₁ (14.02 mm). The highest stem diameter with respect to spacing was recorded in wider spacing 50 × 60 cm might be due to low plant population with results in optimum space available for plant growth as well as availability of nutrients, light, soil moisture and aeration. A significant variation was observed on stem diameter in organic manure. The highest stem diameter was recorded in M₁ (17.63 mm) whereas, the lowest stem diameter was recorded in M₄ (13.66 mm). The highest stem diameter reported in application of FYM @ 10 t/ha + 100:50:50 kg/ha NPK might be due to optimum availability of essential nutrients. Further, the beneficial role of FYM in improving physico-chemical as well as biological property of soil which resulted in favourable condition for absorption of essential nutrients by plants. This might be attributed to multifarious role of FYM and NPK in supply of nutrients as well as improvement in physical, chemical and biological environment of soil. Finally, it was reflected in better growth of plant with FYM. The interaction effect on stem diameter was found to be significant. The highest stem diameter of Indian spinach was recorded in S₃M₁ (19.86 mm) whereas, the lowest was recorded in S₁M₄ (12.44 mm).

Number of leaves

The highest number of leaves were observed in S₂ (52.61) and the lowest number of leaves were recorded in S₁ (48.33). The highest number of leaves were recorded in optimum spacing S₂ whereas, the lowest were observed in S₁ *i.e.* closer spacing. The highest number of leaves were recorded in optimum spacing might be due to number of leaves remarkably accelerated under optimum spacing and relatively least competition exerted between crop plants which important role in enhancing the vegetative growth resulting higher number of leaves. The plants grown with optimum spacing 50 × 45 cm received higher amount of light, nutrient, water thus attaining more height along with more number of leaves per plant and the reverse happened to plants grown with closer spacing *i. e.* S₁ (50 × 30 cm). It is evident from the data the effect of organic manure on number of leaves of Indian spinach was found to be significant. The highest number of leaves were recorded in M₁ (55.59) whereas, the lowest number of leaves were recorded in M₄ (45.62). It was noticed that the number of leaves were recorded highest with M₁ *i. e.* application of FYM @ 10 t/ha + 100:50:50 kg/ha NPK might be due to higher availability of nitrogen, phosphorus and potassium to the plants initially through inorganic fertilizer along with FYM, as well through fulfilling the needs of plant throughout the cropping season. The interaction effect of spacing and organic manure showed significant variation on number of leaves. However, the highest number of leaves were recorded in S₂M₁ (58.18) and the lowest were recorded in S₁M₄ (43.07). The higher number of leaves were recorded with treatment combinations S₂M₁ (50 × 45 cm spacing along with FYM @ 10 t/ha + 100:50:50 kg/ha NPK) might be due to favorable combination effect of spacing and organic manure on number of leaves of Indian spinach.

Table 2: Effect of spacing and organic manure on number of leaves and number of branches of Indian spinach

Treatments	Number of leaves				Number of branches			
	S ₁	S ₂	S ₃	Mean	S ₁	S ₂	S ₃	Mean
M ₁	53.20	58.18	55.40	55.59	10.07	12.74	12.36	11.72
M ₂	45.53	50.05	47.47	47.68	8.88	12.43	11.89	11.07
M ₃	51.53	54.07	51.53	52.38	9.92	12.57	12.22	11.57
M ₄	43.07	48.13	45.67	45.62	8.77	12.13	11.48	10.79
Mean	48.33	52.61	50.02		9.41	12.47	11.99	
	S	M	S × M		S	M	S × M	
F-test	Sig	Sig	Sig		Sig	Sig	Sig	
S.E.m ±	0.014	0.019	0.06		0.0004	0.0006	0.0017	
CD at 5%	0.041	0.054	0.16		0.0012	0.0016	0.0049	

Number of branches

The highest number of branches were observed in S₂ (12.47) and the lowest number of branches were recorded in S₁ (9.41). The highest number of branches with respect to spacing was recorded in optimum spacing 50 × 45 cm might be due to optimum plant population with results in optimum space available for plant growth as well as availability of nutrients, light, soil moisture and aeration. Similar results with respect to spacing obtained by Islam *et al.* (2014)^[6], in Indian spinach. It is evident from the data the effect of organic manure on number of branches of Indian spinach was found to be significant. The highest number of branches were recorded in M₁ (11.72) whereas, the lowest number of branches were recorded in M₄ (10.79). The highest number

of branches reported with application of FYM @ 10 t/ha + 100:50:50 kg NPK/ha might be due to optimum availability of essential nutrients (both major and minor). Further, the beneficial role of FYM in improving physico-chemical as well as biological property of soil which resulted in favourable condition for absorption of essential nutrients by plants. This might be attributed to multifarious role of FYM and NPK in supply of nutrients as well as improvement in physical, chemical and biological environment of soil. Finally, it was reflected in better growth of plant with FYM. The interaction effect of spacing and organic manure showed significant variation on number of branches. However, the highest number of branches were recorded in S₂M₁ (12.74) and the lowest were recorded in S₁M₄ (8.77).

Table 4: Effect of spacing and organic manure on herbage yield per hectare of Indian spinach

Treatments	Herbage yield per hectare (t)			
	S ₁	S ₂	S ₃	Mean
M ₁	31.72	22.07	15.36	23.05
M ₂	26.34	19.02	13.26	19.54
M ₃	28.77	20.48	14.40	21.22
M ₄	24.04	17.30	12.20	17.85
Mean	27.72	19.72	13.81	
	S	M	S × M	
F-test	Sig	Sig	Sig	
S.E.m ±	0.035	0.047	0.141	
CD at 5%	0.103	0.137	0.412	

Yield per hectare (t/ha)

The highest total herbage yield per hectare (27.72 t) was found in S₁ (50 × 30 cm) and it was found significantly superior. The lowest total herbage yield per hectare (13.81 t) was recorded in S₃ (50 × 60 cm). The highest total herbage yield per hectare with respect to spacing was recorded in S₁ might be due to more plant population. Similar results with respect to spacing obtained Mane *et al.* (2008)^[7] in spinach. Among the different organic manure tried under present investigation there was significant effect on total herbage yield per hectare of Indian spinach. The highest total herbage yield per hectare (23.05 t) was recorded with treatment M₁ and it was found significantly superior over rest of the organic manure levels. However, the lowest total herbage yield per hectare (17.85 t) was found in M₄. The highest total herbage yield per hectare was recorded with application of FYM @ 10 t/ha + 100:50:50 kg/ha NPK might be due to higher availability of nitrogen, phosphorus and potassium to the plants initially through inorganic

fertilizers along with FYM fulfilling the needs of plant throughout the cropping season. Similar results with respect to organic manure obtained by Padmanabha *et al.* (2009)^[8] in Palak and Hashimi *et al.* (2019)^[5] in spinach. This might be attributed to multifarious role of FYM and NPK in supply of nutrients as well as improvement in physical, chemical and biological environment of soil. Finally, it was reflected in better growth of plant with FYM. The highest total herbage yield per hectare (31.72 t) was recorded with treatment combination S₁M₁ and it was found significantly superior over all treatment while, S₃M₄ recorded the lowest total herbage yield per hectare (12.20 t). The highest total herbage yield per hectare was recorded in S₁M₁ might be due to higher plant population further, with respect to organic manure the highest total herbage yield per hectare reported with M₁ can be attributed to higher availability of nitrogen, phosphorus and potassium to the plants initially through FYM as well through inorganic fertilizers fulfilling the needs of plant throughout the cropping season.

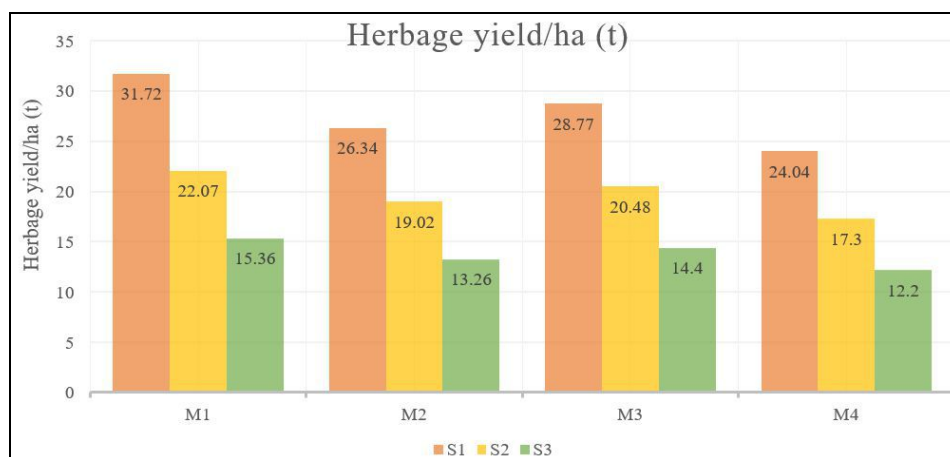


Fig 1: Herbage yield/ha (t)

Conclusion

Based on the present investigation, it may be concluded that the treatment S_1 (50×30 cm) was found to be the most profitable with respect to different spacing whereas, for the higher yield organic manure FYM @ 10 t/ha +100:50:50 kg/ha NPK was economically best. Considering the interaction effect of different spacing and organic manure the treatment S_1M_1 (50×30 cm with manure FYM @ 10 t/ha +100:50:50 kg/ha NPK) was found to be most profitable for obtaining higher yield.

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