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Effect of Different Planting Material and Methods of Planting on Growth and Yield of Indian Spinach (*Basella rubra* L.)

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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

In recent years, the demand and the awareness for underexploited vegetables and their nutritional importance is increasing. Hence, with a view to stimulate the production of Indian spinach, a field experiment was conducted at College of Horticulture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Maharashtra in 2023-2024. The eight treatment combinations comprising two

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different planting materials seedlings (P1) and rooted cuttings (P2) with four various methods of planting viz., flat bed (M1), raised bed (M2), ridges and furrows (M3) and broad ridge (M4) were tested under Factorial Randomized Block Design with three replications. The seedling recorded comparatively maximum stem diameter (12.71mm), number of leaves (68.58) and number of branches per plant (9.08) as compared to rooted cuttings. Similar results were also recorded for yield related attributes. Among the yield attributes maximum herbage yield per plant (247.73g) and total herbage yield per plot (14.86 kg) recorded with seedling. Among methods of planting broad ridge planting recorded significantly highest stem diameter (12.78mm), numbers of leaves (72.83) and number of branches (9.10). Yield parameters viz. total herbage yield per plant (273.03 g) and herbage yield per plot (16.75 kg) was significantly higher with broad ridge planting as compared to flat bed method. Hence, Indian spinach (*Basella rubra* L.) grown by the seedlings on broad ridges (P1M4) showed better performance with regards to growth and yield attributing parameters especially in areas with high rainfall.

Keywords: Seedlings; rooted cuttings; broad ridge; raised bed; ridges and furrows; yield.

1. INTRODUCTION

Basella is a leafy herbaceous perennial vine native to Tropical Asia (India and Indonesia) and Africa. Basella is commonly known as Indian Spinach, Malabar Spinach, Malabar Nightshade, Ceylon Spinach, Climbing Spinach and Vine Spinach. In Eastern India, it is known as *poi* as well as mayalu and it is a popular leafy vegetable which fetches good market price for the farmers during the summer months Kannan et al. [1]. This plant is also reputed as multivitamin green. Basella rubra is a good source of Calcium, Iron, Vitamin A, C and K. In the winter season, Malabar spinach can be used in place of normal spinach as it has similar nutritional and medicinal value Chaurasiya et al. [2]. Besides these all the plant possesses a valuable ethnomedicinal importance and are used to cure digestive disorders, skin diseases, bleeding piles, pimples, urticaria, irritation, anemia, whooping cough, leprosy, aphthae, insomnia, cancer, gonorrhea, burns, headache, ulcers, diarrhea, liver disorders, bilious vomiting, sexual asthenia Deshmukh and Gaikawad [3]. The young leaves can be eaten fresh in salads, or can be lightly steamed and used like spinach. It is consumed in the form of Dal, Chutney, Soup, Curry, and other various forms. In coastal region of Maharashtra, the leaves are used to make *pakoras,* curry and savory dishes.

It can be grown easily under any soil type and can survive in varied climatic conditions. It is one of the leafy vegetables which can be grown either in backyard or commercially during whole rainy season. Basella prefers warm to tropical climate in warm-temperate climates, it is an excellent species in climates that are too hot for most salad crop [4,5]. In Maharashtra the climatic conditions of Konkan region are warm and humid which is ideal for cultivation of Basella. Considering the Konkan region leafy vegetables are the essential part of their diet. But due to high rainfall conditions it is difficult to cultivate leafy greens like amaranths, fenugreek, spinach, etc. whereas the Basella has the potential to sustain high rainfall conditions. Basella is a perennial leafy vegetable and are grown to use as a spinach substitute [6,7]. Appropriate propagation material and proper planting method is the most critical factor for realizing desired yield potential. As we all know, the farmer's practice planting over flatbed without any proper planting method, leading to less significant growth and development of crops and in turn lesser yield. Therefore, it is necessary to know about the suitable method of planting for proper growth and development of many crops Deshmukh and Vasave [8] in cereals. In regards of above points in view an experiment, "Effect of planting material and methods of planting on growth and yield of Indian spinach (*Basella rubra* L.)" was conducted to find out the best combination to derive the rapid growth and yield of basella.

2. MATERIALS AND METHODS

The field experiment was conducted at Department of Vegetable Science, College of Horticulture, Dapoli, Maharashtra. During the year 2023-2024. Dapoli is located between 17°74' N latitude and 73°18' E longitude and it is 240 meters above mean sea level. The climate is hot and humid and it receives annual rainfall from 3000 to 4000 mm.

The experiment was laid out in Factorial Randomized Block Design with three replications and eight treatment combinations. This includes two types of planting material (seedlings and rooted cuttings) and four levels of planting

methods each (flat bed, raised bed, ridge and furrow, broad ridge). The treatment combination *viz.* P_1M_1 – (seedlings + planting on flat beds), P_1M_2 (seedlings + planting on raised beds), P_1M_3- (seedlings + planting on ridges and furrows), P_1M_4- (seedlings + planting on broad ridge), P_2M_1- (rooted cuttings + planting on flat beds), P_2M_2- (rooted cuttings + planting on raised beds), P_2M_3- (rooted cuttings + planting on ridges and furrows), P_2M_4- (rooted cuttings + planting on broad ridge).

Seeds were sown initially to produce seedlings. Semi- hardwood cuttings were selected with 2-3 nodes for rooted cuttings. There was total 8 treatment combinations in each replication and in all there were 24 treatment combinations. Total 60 plants were transplanted on each plot by making 15 cm deep pits having 45 cm X 30 cm row to row and plant to plant distance. The flat bed was the smooth plain surface of 3m X 2.7m. The raised beds were prepared having 30 cm height and 3m X 2.7m size. Whereas in ridges and furrows method, there was six ridges having 3 m length and 30 cm height. Broad ridges were prepared three ridges having 3 m length, 75 cm width and 30 cm height each.

Total 10 plants were selected randomly for recording biometric observations. Observations like stem diameter, number of leaves and number of branches were recorded at every month. Stem diameter at collar region was measured using Vernier Caliper and expressed in Millimeters. Number of leaves was counted from all the observation plants. The number of branches per plant was counted and average of ten plants was computed

Whereas the herbage yield per plant (g) and total herbage yield per plot (kg) were taken average from 30 to 180 DAP. Green, mature tender shoots were harvested from observation plants and weight of these plants is recorded as herbage yield per plant. Green, mature tender shoots was harvested from each treatment (each plot) including ten observation plants and weight of the plants was recorded as herbage yield per plot. The statistical analysis of the data was done by using the standard methods as described by Panse and Sukhatme [9]. Other cultural and plant protection practices were followed as per the recommendation.

3. RESULTS AND DISCUSSION

3.1 Effect of Planting Material

Growth parameters: The different planting material had significant effect on plant height, stem diameter, number of leaves and number of branches during experimentation (Table 1). At 180 DAP the highest plant height was recorded by seedling P_1 (33.35cm) originated plants. These results indicate that the plants originated from cuttings tend to be dwarf irrespective of the stages of growth. Similar results were also found by Amruta and Satheeshan [10] in marigold and Alam [11] et al. in Purslane. Similarly, the highest stem diameter (12.71mm) was recorded from seedlings (P_1) originated plants and lowest was recorded under rooted cuttings plants.

Furthermore, the highest number of leaves (68.58) and number of branches (9.08) was recorded from seedling originated plants (P_2) and lowest was recorded from rooted cuttings (P_1). It might be due to seedling has tap root system, which helps to absorb water and nutrient from soil easily and it is essential to make plants taller, stronger and well branched. Whereas the cuttings have shallow root system and low survival of rate was observed in this study could be due the fact that roots did not seem to develop fast enough to start providing nutrients to the cuttings from the soil. The similar results were also reported by Meera [12] in adakodien (Holostemma annulare k. Schum) a medicinal plant, Kiragu et al. [13] in *Moringa oleifera*.

Yield parameters: Similar trend was also observed for yield parameters; the result revealed that effect of planting material on herbage yield per plant and per plot in Indian spinach was found significantly maximum. It was observed that seedling recorded the highest total herbage yield per plant (247. 73g/plant) and total herbage yield per plot (14.86 kg/plot) Tables 2 and 3. The similar result was found by Sharma et al. [14] in Lettuce.

3.2 Effect of Methods of Planting Methods

Growth parameters: Methods of planting had significant effect on growth and yield attributes. Plant height recorded the highest (34.33cm) with ridge and furrow (M_3) method of planting which was found at par with treatment M_4 (34.16cm) and M_2 (33.86cm). Whereas, the flat bed (29.40cm) recorded the lowest plant height. This might be due to aeration, more conservation of water, maintained favorable condition and initial vigorous growth in ridge and furrow resulted in more plant height of the crop. The similar findings were observed by Neha et al. [15] in pigeon pea, Parmar et al. [14] in radish. Broad ridge method of planting resulted in significantly highest stem diameter

(12.78mm), number of branches per plant (9.10) and number of leaves per plant (72.83) compared to the flat bed method of sowing (Table 1). Also broad ridges are superior planting method as they provide better drainage, improved aeration, faster soil warming, easier weed control, and ultimately a higher number of leaves. A raised structure can improve light exposure and increase photosynthesis rate. Similar observations have been reported by Modupeola et al. [16] in lagos spinach, Maheriya et al. [13] in radish and Solangi et al. [17] in spinach.

Yield parameters: Similar trend was also observed with yield parameters. The result presented in Table 2 and 3 revealed that the broad ridge method (M_4) of methods of planting significantly influenced on yield parameters. Significantly the highest total herbage yield per plant (273.039g/plant) and per plot (16.75kg/plot) was recorded in methods of planting M_4 which was followed by (M_2) raised bed method. The lowest herbage yield per plant (200.02g/ plant) and herbage yield per plot (12.05kg/plot) recorded with treatment M_1.

Table 1. Effect of planting material and methods of planting techniques on growth parameters inIndian spinach (*Basella rubra* L.)

Treatment	Growth parameters (180 DAP)			
	Plant height (cm)	**Stem diameter** (mm)	**umber ofleaves**	**Number of branches**
P_1	33.35	12.71	68.58	9.08
P_2	32.51	12.21	66.13	8.40
S.E.m±	0.20	0.07	0.24	0.11
CD@5%	0.62	0.23	0.73	0.33
Result	Sig.	Sig.	Sig.	Sig.
M_1	29.40	11.77	60.83	7.79
M_2	33.86	12.72	69.09	9.09
M_3	34.30	12.57	66.67	8.99
M_4	34.16	12.78	72.83	9.10
S.E.m±	0.92	0.20	0.63	0.36
CD@5%	2.78	0.61	1.91	1.10
Result	Sig.	Sig.	Sig.	Sig.
P_1M_1	29.68	11.89	63.00	7.84
P_1M_2	33.07	12.83	70.00	9.10
P_1M_3	35.63	12.79	67.67	9.60
P_1M_4	35.01	13.32	73.67	9.79
P_2M_1	29.12	11.66	58.67	7.74
P_2M_2	34.66	12.61	68.18	9.08
P_2M_3	32.97	12.34	65.67	8.37
TP_2M_4	33.30	12.24	72.00	8.40
S.E.m±	0.41	0.15	0.48	0.22
CD@5%	1.23	0.45	1.46	0.66
Result	Sig.	Sig.	Sig.	Sig.

Table 2. Effect of planting material and methods of planting techniques on herbage yield/plant inIndian spinach (*Basella rubra* L.)

Treatment	Total herbage yield per plant (g)				
	M_1	**M_2**	**M_3**	**M_4**	**Mean**
P_1	193.01	275.23	245.63	277.07	247.73
P_2	207.04	252.45	230.85	268.98	239.83
Mean	200.02	263.84	238.24	273.03	243.78
	S.Em±	CD@5%		Result	
Material(P)	0.26	0.79		SIG	
Methods(M)	7.90	23.97		SIG	
Interaction (PXM)	0.52	1.57		SIG	

Table 3. Effect of planting material and methods of planting techniques on herbage yield/plot in Indianspinach (*Basella rubra* L.)

Treatment	**Total herbage yield per plot** (kg) **(30 to 180 DAP)**				
	M_1	**M_2**	**M_3**	**M_4**	**Mean**
P_1	11.58	16.06	14.74	17.07	14.86
P_2	12.51	15.15	13.80	16.42	14.47
Mean	12.05	15.61	14.27	16.75	14.67
	S.Em±	**CD@5%**		**Result**	
Material(P)	0.03	0.10		SIG	
Methods(M)	0.45	1.35		SIG	
Interaction (PXM)	0.07	0.21		SIG	

The plants in broad ridges often develop stronger root systems and healthier foliage, leading to increased yield. More field accessibility under broad ridge method for post planting intercultural operations makes it superior to raised bed and ridge and furrow methods. Higher herbage yield in broad ridge method might be associated to corresponding increase in number of leaves. The results are in agreement with the reports of Dikey et al. [18] in turmeric, Chaturvedi et al. [19] in cowpea and Chandra et al. [20] in safed musli,

3.3 Interaction Effect of Planting Material and Methods of Planting

Growth parameters: From the data placed at Table 1, it was evident that plant height, stem diameter, number of leaves and number of branches were affected significantly due to interaction between planting material and methods of planting. The treatment combination (P_1M_3) seedling + ridges and furrow recorded significantly highest plant height and the lowest plant height was recorded by treatment P_2M_1 (29.12cm) which were found at par with P_1M_1 (29.68cm). However, P_2M_1 recorded the highest stem diameter (13.32mm), number of branches (9.79) and number of leaves (73.67) which was found significantly superior over all the treatment.

Yield parameters: The interaction effect of methods of planting and planting material was significantly felt on total herbage yield of plant. The highest total herbage yield per plant (277.07g/plant) and herbage yield per plot (17.07 kg/plot) was recorded with treatment P_1M_4 which was superior over rest of the treatment combinations. Seedling plants showed slower but more vigorous growth, with a higher relative yield of leaves and also it has tap root system. In broad ridge soil moisture was periodically maintained in the root zone as well as it minimized run off (Vekariya *et al* [17] in Groundnut. Also, it provides better availability of nutrients and moisture to the crop and less competition for natural resources. The similar results was also found by Pandey et al. [15] in black gram.

4. CONCLUSION

According to the whole research studied in the area of planting material and different methods of planting in Indian spinach, it may be stated that use of appropriate planting material and method of planting, especially seedling planted on broad ridges supports the growth and development of Indian spinach along with increase in the yield.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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