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Growth and Yield of *Basella alba* L. in Relation to the Propagation Method and the Growth Media

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ABSTRACT

An attempt has been made in the present investigation to study the performance of five propagating materials viz. normal seeds, scarified seeds, two node cuttings, four node cuttings and tip cuttings to grow out and perform in three growth media viz. soil only, sand only and soil+sand (1:1) mixture. The experiment was laid out in Completely Randomized Design having three replicates. A total of 15 treatment combinations were under study. The treatment combination comprised of two factors viz. Factor 1 = M (Media) and Factor 2 = P (Propagating material). Survivability percentage was highest (100%) in 4 node cutting in soil followed by 2 node cutting in sand and tip cutting in sand. Length of the vine was maximum in tip cutting in soil throughout the period of experiment. Girth of the stem was highest in 2 node cutting in sand during the initial growth stage, however at 45 days after sowing (DAS) it was highest in seed sown in sand+soil (1:1). Number of nodes on the stem was highest in tip cutting in soil due to its rapid stem formation and throwing out of new shoots from the nodal points. The maximum internodal length was observed in tip cutting at soil as compared to others. Result of number of nodes and internodal length at different DAS are correlated and noted that with rise in the number of nodes, the inter nodal length also increased. Increment in number of side shoots was highest in seed sown in soil and least in scarified seed in sand. Number of leaves/plants was highest in 4 node cutting in sand at 15 DAS, however at 30 DAS total no. of leaves/plant was highest in tip cutting in soil. Length and width of leaf was highest in seed in sand+soil media (1:1). Number of prominent veinlets was highest in 4 node cutting in sand + soil (1:1). Total leaf area was highest in scarified seed in sand+soil (1:1). Number of lateral roots was highest in tip cutting in sand and least in 2 node cutting in sand at 45 DAS. Average weight of the roots/plant was higher in seed sown in sand + soil (1:1) having more stouter roots. Edible fresh weight /plant was highest in seed grown in sand +soil (1:1) and least in scarified seed in sand. In the present findings, soil +sand mix was a better option than soil alone due to optimal holding of water and maintenance of turgor pressure in the leaves. It may be concluded that growth media significantly influenced the growth and ultimately the yield in *Basella*. Strong correlation existed among the growth media and propagating materials under study.

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The highest yield was observed in seed grown under sand+soil mix (1:1), followed by tip cutting, 4 node cutting and 2 node cutting.

Keywords *Basella*, Propagation, Seeds, Cutting, Growth media.

INTRODUCTION

Malabar spinach (*Basella alba* L., syn.: *Basella rubra* Roxb.) belongs to the Basellaceae family. *Basella* is indigenous to tropical Southern Asia, probably from India or Indonesia. *Basella alba* is commonly grown in Malaysia, Philippines, Tropical Africa, the Caribbean and tropical South America and Southeast of Brazil (Deshmukh and Gaikwad 2014). Almost in every part of India, *Basella* is grown as a pot herb (Khanom *et al.* 2019). Malabar spinach can be eaten raw in salads as a replacement for leafy greens or can be cooked in different dishes.

Basella is cultivated worldwide up to an elevation of 2600 m. It can also be grown below 500 m where the climate is dry to humid. It requires warm days for good production. The plant grows optimum at 32°C, however when temperature drops to 26°C development is depressed. The optimum temperature for seed germination is 18-23°C. Well-drained fertile sandy loam soil and full sun to partial shade situations is ideal for its growth. It can grow in soil with a pH range of 5.5-7 but can tolerate 4.3-7.5.

Basella alba L. is a perennial twining herb. It is a short-day plant and flowering is inhibited at a day length longer than 13 hrs. It responds to light shading by producing larger and more succulent leaves than when fully exposed. It is one of the tropical species that has a C_4 photosynthetic pathway, resulting in fast photosynthesis and high dry matter production under high light intensity, high temperature and adequate moisture and soil fertility. Leaves of *Basella* are rich in carotenoids, organic acids and water-soluble polysaccharides, bioflavonoids and vitamin-K (Chaurasiya *et al*. 2021).The mucilaginous liquid obtained from the leaves and tender stalks is a popular remedy for habitual headache. It is used as a good thickening agent in pharmaceutical and cosmetic industries. The gel obtained from the mucilage is used as medicine for skin problems due to its antioxidant activity. *Basella alba* reproduces by seeds and vegetatively by stem cuttings and rhizomes. It will also form roots when stem nodes touch the ground (Dave's Garden 2017). Reproduction of *Basella alba* using different media composition, seeding and cutting techniques resulted in significant observations regarding survivability and characteristics of plants under study. Hence, the sole aim of the experiment was to study the performance of five propagating materials viz. normal seeds, scarified seeds, two node cuttings, four node cuttings and tip cuttings to grow out and perform in three growth media selected for this study viz. soil only, sand only and soil + sand (1:1) mixture followed by evaluation of the best combination of "Growing media and Propagating material".

MATERIALS AND METHODS

The study was conducted at Patrasayer Block, Eastern part of the Bankura District, (23^0 13'00''N, 87^0 31'00''E), from June to August, 2021. The average temperature recorded during the period of experimentation was 34.2 to 32.3°C with a relative humidity of 82.45 to 85.76%. Area covered for planting was 460 sq feet with plot size measuring 4 × 2.5 m. The experiment was laid out in Completely Randomized Design with two factors viz., media (soil, sand and soil+sand mix in 1:1 ratio) and propagating material (seed, scarified seed, two node cutting, four node cutting and tip cutting) having three replicates with a total of 15 treatment combinations (Table 1). The plant population per plot was kept at eight per plot, of which four were randomly selected for recording of observations. Soil was ploughed to a fine tilth followed by sterilization of the media with hot water and drenching with Bavistin 50 WP@ 2g/l prior to planting. Seeds of *basella* were procured from the local market of Bankura. For vine cuttings, it was collected from the locality. Three types of cuttings were used for planting as propagating materials i.e., Tip cutting (15 cm), two node cutting (8-12 cm) and four node cutting (12-20 cm). Seeds were sown and cuttings were planted in experimental plots in mid June at a spacing of 1 × 1 m. Whole seeds as well as scarified seeds were soaked in water overnight for faster germination. Necessary care was taken, so that the cuttings were not exposed to direct sunlight

Table 1. Treatment details of the experiment.

Notations	Treatment details
T_1	Seed sown in soil only (control)
T_2	Scarified seed sown in soil
T_3	Two node cutting sown in soil
T_4	Four node cutting sown in soil
T_5	Tip cutting sown in soil
T_6	Seed sown in sand
T_7	Scarified seed sown in sand
T_8	Two node cutting sown in sand
T_9	Four node cutting sown in sand
T_{10}	Tip cutting sown in sand
T_{11}	Seed sown in soil + sand (1:1)
T_{12}	Scarified seed sown in soil+sand (1:1)
T_{13}	Two node cutting sown in soil +sand (1:1)
T_{14}	Four node cutting sown in soil +sand (1:1)
T_{15}	Tip cutting sown in soil+sand (1:1)

to prevent etiolation. Observations on different parameters were taken on 15th, 30th and 45th day after sowing the seed or planting of the vine except for some parameters which were taken on either of the days. The statistical analysis for various parameters was done using statistical package Two-way Factorial CRD software.

RESULTS AND DISCUSSION

Data pertaining to Table 2 revealed that highest percentage of survivability of the seedlings was observed in T_4 (99%) followed by T_8 (97.50%), T_{10} (97.00%) and T_{11}(91%). The least (61.00%) was observed in T_7. Our observations are in agreement with Dubey and Pandey (1973) who reported that cuttings of pointed gourd from the basal portion of vines have shown 90% success.The study revealed (Table 2) that maximum vine length of 19.08 cm, 63.99 cm and 98.25 cm at 15, 30 and 45 DAS respectively was observed in T_5 (tip cutting sown in soil) while minimum (3.12 cm, 8.18 cm and 13.18 cm) vine length was observed in T_7 (scarified seed sown in sand). It depicts that plant propagated by seed displayed slow but vigorus growth while the plants propagated by cuttings showed fast initial growth. Similar result was obtained by Campos *et al.* (2012). Regarding girth of stem (Table 2) it was higher in T_8 (two node cuttings sown in sand) at 15 and 30 DAS (4.10 cm, 4.45 cm) and was superior to four node cutting, tip cutting and plant propagated by seeds. With ageing of the plant, it was observed that T_{11} out performed others with respect to girth of stem on 45th day of observation. The increment in girth was highest in T_{11} from 30 to 45 DAS i.e., 2.95 cm. The reason behind it may be due to mixing of soil and sand which helps in rapid proliferation of the roots leading to better nutrient flow from the roots to other parts of plants thus making the vascular cambium to enlarge and develop the secondary growth. Lowest girth of stem T_6 (seed sown in sand) 0.55 cm, T_2 (scarified

Table 2. Influence of different treatments on the survivability of the seedlings, vine length and girth of stem of *Basella alba* L.

Treatments	Survivability of the seedlings (%)	Vine length (cm)			Girth of stem (cm)		
		15 DAS	30 DAS	45 DAS	15 DAS	30 DAS	45 DAS
T_1	72.50	8.59	23.42	33.30	0.70	1.70	4.10
T_2	74.00	9.34	22.12	30.35	0.70	1.65	4.40
T_3	75.00	5.49	9.99	17.00	3.35	3.75	3.90
T_4	99.00	3.66	27.86	56.40	2.66	3.06	3.20
T_5	89.00	19.08	63.99	98.25	1.70	2.55	2.95
T_6	72.00	3.27	9.45	14.55	0.55	1.65	2.65
T_7	61.00	3.12	8.18	13.18	0.60	1.85	2.35
T_8	97.50	4.56	10.31	16.10	4.10	4.45	4.55
T_9	87.50	4.23	19.31	47.00	3.11	3.36	3.35
T_{10}	97.50	17.99	32.99	47.75	1.45	2.35	3.00
T_{11}	91.00	10.53	28.95	38.45	0.75	1.90	4.85
T_{12}	69.00	10.45	22.75	30.55	0.75	1.82	4.35
T_{13}	89.00	4.06	12.03	18.45	3.70	4.10	4.25
T_{14}	88.00	4.11	25.39	48.80	3.09	3.04	3.25
T_{15}	79.00	17.06	52.33	92.75	1.80	2.35	4.10
CV%	**3.63**	**11.95**	**12.51**	**15.39**	**10.19**	**5.95**	**4.09**
CD 5%	**6.41**	**2.14**	**6.60**	**13.27**	**0.42**	**0.33**	**0.31**

Table 3. Impact on number of nodes, internodal length and increment in number of side shoots in different treatments of *Basella alba* L.

Treatments	Number of nodes			Internodal length			Increment in number of side shoots	
	15 DAS	30 DAS	45 DAS	15 DAS	30 DAS	45 DAS	30 DAS	45 DAS
T_1	2.90	7.75	13.35	0.75	1.57	1.75	5.00	8.85
T_2	3.35	7.05	13.40	0.65	1.65	2.20	3.95	7.65
T_3	3.29	4.49	7.80	0.42	0.74	1.10	1.90	4.35
T_4	3.75	9.54	13.75	1.13	1.86	2.12	3.75	4.45
T_5	14.66	20.16	26.93	3.15	3.46	3.65	2.95	4.87
T_6	2.00	3.67	4.25	0.40	0.80	1.52	1.70	2.90
T_7	2.70	4.40	5.00	0.60	1.00	1.72	1.20	3.35
T_8	3.29	4.58	8.65	0.37	1.05	1.00	2.35	3.90
T_9	4.22	6.91	11.40	0.90	1.42	1.52	3.45	4.00
T_{10}	9.83	15.06	18.25	1.00	1.28	1.58	2.50	4.25
T_{11}	3.75	6.50	16.65	0.53	2.36	2.70	4.93	8.75
T_{12}	3.83	7.55	11.25	0.47	1.95	2.25	2.30	5.35
T_{13}	4.28	6.59	10.66	0.53	0.96	1.33	2.47	3.45
T_{14}	4.60	7.55	11.95	1.47	2.39	2.32	3.20	3.90
T_{15}	11.83	16.86	22.37	2.65	3.17	3.32	3.65	3.85
CV%	**13.19**	**4.54**	**6.02**	**9.353**	**5.262**	**5.374**	**5.828**	**3.803**
CD 5%	**1.47**	**0.83**	**1.68**	**0.209**	**0.192**	**0.231**	**0.378**	**0.402**

seed sown in soil) 1.65 cm and T_6 (seed sown in sand) 1.65 cm and T_7 (scarified seed sown in soil) 2.35 cm were observed in 15, 30 and 45 DAS respectively.

From the given Table 3, it is clear that Tip cutting sown in soil (T_5) had the highest (14.66, 20.16 and 26.93) number of nodes whereas the least was observed in T_6 (seed sown in sand) at 15, 30 and 45 DAS. Treatments T_1, T_2 and T_4 were at par, while T_5 and T_{15} results were close to each other. Tip cuttings extended rapidly in soil media with rapid root formation resulting in uptake of nutrient from the soil which

Table 4. Effect of different treatments on total number of leaves, leaf length, leaf width, number of prominent veinlets and total leaf area in *Basella alba* L.

Treatments	Total number of leaves/vine			Leaf length (cm)	Leaf width (cm)	Number of prominent veinlets	Total leaf area (cm^2)
	15 DAS	30 DAS	45 DAS	30 DAS	30 DAS	30 DAS	30 DAS
T_1	6.00	12.41	20.65	11.66	7.76	13.15	20.12
T_2	5.75	11.45	18.00	11.55	7.25	14.05	25.25
T_3	6.62	13.12	19.35	7.30	4.00	11.45	23.87
T_4	11.05	19.38	27.50	7.55	5.60	14.13	30.62
T_5	8.85	24.66	31.25	7.30	5.25	14.20	27.25
T_6	2.60	7.16	9.20	5.05	3.50	10.65	10.25
T_7	2.50	8.84	19.05	4.55	3.25	11.50	7.55
T_8	7.95	12.95	24.25	5.35	3.50	12.85	8.80
T_9	13.67	21.10	24.75	7.10	4.15	15.16	24.60
T_{10}	8.10	18.85	24.25	7.30	4.80	14.16	19.65
T_{11}	5.60	16.16	24.75	14.82	8.45	15.45	33.92
T_{12}	5.58	12.23	21.25	11.60	7.10	12.45	45.65
T_{13}	6.66	14.75	21.00	6.00	4.15	13.65	25.13
T_{14}	9.95	17.35	26.00	6.90	5.55	17.10	30.62
T_{15}	10.00	21.60	29.30	7.30	4.95	16.25	20.12
CV%	**8.64**	**3.93**	**6.83**	**5.71**	**3.88**	**2.84**	**4.126**
CD 5%	**1.37**	**1.28**	**3.32**	**0.99**	**0.44**	**0.84**	**2.139**

Table 5. Total number of lateral roots per plant, average weight of roots per plant and edible fresh weight per plant as influenced by treatments in *Basella alba* L.

Treatments	Number of lateral roots/plant	Average weight of roots/plant (g)	Edible fresh weight/plant g)
T_1	17.55	6.25	67.75
T_2	21.85	5.60	76.00
T_3	12.50	3.00	26.50
T_4	21.75	4.25	55.50
T_5	21.25	5.30	73.25
T_6	15.40	1.90	13.70
T_7	14.60	2.30	8.75
T_8	12.15	5.15	28.50
T_9	22.80	5.25	62.50
T_{10}	27.45	3.90	29.00
T_{11}	17.70	9.25	136.50
T_{12}	19.50	7.15	61.50
T_{13}	12.50	3.65	31.50
T_{14}	22.25	4.35	41.00
T_{15}	26.50	4.85	60.00
CV%	**8.190**	**10.491**	**9.936**
CD 5%	**3.347**	**1.0821**	**10.968**

promotes initiation of buds thus initiating more number of nodes in *Basella*. Maximum internodal length was observed in T_5 (3.15 cm, 3.46 cm and 3.65 cm) throughout the period of experimentation. Soil media may have attributed to internodal length resulting in elongation of stem and results infer that with rise in the number of nodes, the internodal length was also high, though in many of the crops it is reverse. Also, two node cutting didn't fair well in any of the media, which may be attributed to its slower growth and poor extension of the intermodal (0.74 cm, 1.00 cm) length.

Proliferation of side shoots took (Table 3) place in T_1 (control) at a faster rate over others and had 5.00 and 8.85 number of side shoots at 30 and 45 DAS respectively while minimum were observed in T_7 (scarified seed sown in sand) at 30 and T_6 (seed sown in sand) at 45 DAS. T_1 and T_{11} had close figures followed by T_2 which says that seed sown plants were having better branching over cuttings in soil or soil mix media. The increase may be attributed to triggering of endogenous hormones from seeds, resulting in the formation of more vegetative buds due to flow of nutrients from the soil.

Observations from Table 4 showed that highest (13.67) number of leaves per vine was noticed in T_9 during early days (15 DAS) while least (2.50) was noted in T_7. However, after 30 and 45 days highest (24.66, 31.25) number of leaves per vine was observed in T_5 (tip cutting sown in soil) and least was found on seeds sown in sand media T_5 was closely followed by T_{15} and T_4. Treatments T_8, T_9, T_{10} and T_{11} were at par, the last one being seed based treatment while the rest were cuttings. Tip cuttings at later stages performed better over others due to secured establishment in soil media. More number of leaves per plant resulted in higher yield of *Basella* where the edible portion constitutes the leaves as well as the stem. Our finding is in agreement with El-Eslamboly (2014). Sand media did not result in profuse leaf growth due to rapid loss of moisture from its surface or through leaching. Maximum leaf length (14.82 cm) and leaf width (8.40 cm) at 30 DAS was observed in T_{11} whereas T_7 (scarified seed sown in sand) exhibited least length (4.55 cm) as well as in width (3.25 cm). Treatments T_1, T_{12} and T_2 followed T_{11} in both leaf length and width, however parity was observed only among the three. Leaf length and width promotes major contribution towards yield and in the present findings soil+sand mix (1:1) was a better option than soil alone due to optimal holding of water and maintenance of turgor pressure in the leaves. Leaf length had a significant and positive correlation to leaf width. The proportional rise in leaf length and width also tends to contribute towards the edible fresh weight of the plant. Presence of prominent veinlets at 30 DAS was high in T_{14} (17.10) while it was low in T_6 (10.65). Number of veinlets per leaf didn't associate with increased leaf length and width though the average trend was leaves having better leaf length and width were having good number of veinlets. Larger the number of veinlets, stronger is the leaf structure resulting in increased fresh weight as well as more succulent leaves. The soil+sand mix played a vital role in this regard and cuttings with four nodes were having more luxuriant leaves. Sand media failed to support this trait as the propagating materials raised under this media were mostly having smaller leaves. The greater the number of veinlets, better is the translocation of photosynthates from source to sink.

Total leaf area (Table 4) on 45th day was high in T_{12} (45.65 cm^2) followed by T_{11}, T_{14} and T_4 while it was least in T_7 (7.55 cm^2). T_{12} significantly differed from rest of the treatments. Though the total number of leaves were high in T_{15}, it's total leaf area was half that of T_{12}. Rather than planting material more emphasis needs to be given on the media and the trend showed that sand alone did show negativity on the seedlings as it was low in C : N ratio. However, seedlings raised in sand and soil mixture as well as soil only had pronounced leaf area expansion which may be owing to better GA flow and faster multiplication of cells due to higher auxin levels.

Maximum (27.45) number of lateral roots per plant (Table 5) at 45 DAS was in Tip cutting sown in sand (T_{10}) followed by T_{15} (26.50) while T_8 the least (12.15). Treatments T_2, T_4, T_5, T_9 and T_{14} were at par and the number of lateral roots were 21-22. Sand media is best for quick root formation compared to other media, and also had maximum number of roots per plant and also enhanced root length. Both tip cuttings and 4 node cutting performed well in sand as well as soil + sand mix. The proliferation of the roots in sand media is a strategy by plants for their own survival to maintain the water balance within the plant system. Average root weight was high in T_{11} (9.25 g) while T_6 was having the least (1.90 g). In most of the treatments, the average root weight was in between 4-6. Sand + soil mix were having stouter roots as compared to sand media, the later having more fibrous one. Stouter roots have better anchorage in the soil and they derive nutrients and water at a greater depth than roots observed in sand media which picks up moisture and nutrients mostly from the sub surface.

Maximum (136.50 g) edible fresh weight per plant (Table 5) at 45 DAS was in T_{11} (seed sown in soil + sand) while the minimum (8.75 g) edible fresh weight per plant was in T_7 (scarified seed sown in sand). Few treatments like T_{15}, T_{12}, T_9, T_1, T_5 and T_2 ranged in between 60.00– 76.00 g in ascending order. Campos *et al*. (2012) were of the view that plants grown by seeds displayed slow, but healthy growth with larger relative yield of leaves, while plants propagated by cuttings showed fast initial growth, whose results do partially agree with our findings.

CONCLUSION

On the basis of results obtained in this study, it may be concluded that growth media significantly influenced the growth and ultimately the yield in *Basella*. Strong correlation existed among the growth media and propagating materials under study. The highest yield was observed in seed grown under sand+soil mix (1:1), followed by tip cutting, four node cutting and two node cutting. As *Basella* is a household leafy vegetable consumed in good amounts in Eastern part of India, standardization of protocol is needed by repeating the experiment under different multi-locations so that early yield realization is achieved.

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