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Influence of growing media on germination of PKM-1, PKM-2 and local cultivars of *Moringa (Moringa oleifera)*

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ABSTRACT

A nursery investigation entitled “Influence of growing media on germination of PKM-1, PKM-2 and Local Cultivars of *Moringa (Moringa oleifera)*” was carried out during the Rabi season of 2025–26 at the Department of Horticulture Nursery, College of Horticulture and Research Station, Sankara-Patan, Durg (C.G.). The experiment was conducted in a Factorial Completely Randomized Design (FCRD) with three replications. A total of twelve treatment combinations were evaluated by involving three cultivars and four different growing media. The cultivars comprised V_1 – PKM-1, V_2 – PKM-2 and V_3 – Local Cultivar, whereas the growing media included M_0 – Sand + Soil (1:1), M_1 – Sand + Soil + Cocopeat (1:1:2), M_2 – Sand + Soil + Vermicompost (1:1:2) and M_3 – Sand + Soil + FYM (1:1:2). Various germination characteristics, namely days required for first germination, days required for 50 per cent germination, germination percentage, speed of germination and survival percentage were recorded during the study. In addition, seedling growth attributes such as shoot length, root length, total seedling length, fresh weight, dry weight and number of leaves per seedling was measured. The experimental data obtained for different parameters were subjected to appropriate statistical analysis to assess the individual effects of cultivars and growing media, as well as their interaction and to determine the significance of the observed variations. The findings indicated that considerable variation existed among the cultivars with respect to germination and seedling growth characteristics. Among the cultivars, V_2 – PKM-2 exhibited the earliest germination, requiring 3.89 days for first germination and 5.05 days to attain 50 per cent germination. It also registered the highest germination percentage (90.54%), speed of germination (18.19) and survival percentage (82.39%). In terms of seedling growth, V_2 – PKM-2 recorded the maximum shoot length (37.87 cm), root length (27.04 cm), total seedling length (64.92 cm), fresh weight (17.64 g), dry weight (3.18 g) and number of leaves per seedling (69.45). The performance of V_2 – PKM-2 was significantly superior to that of the other cultivars. Among the different growing media, M_2 – Sand + Soil + Vermicompost (1:1:2) produced the most favorable results for both germination and seedling development. This medium recorded the earliest first germination (3.66 days) and 50 per cent germination (4.76 days), along with the highest germination percentage (91.76%), speed of germination (18.91) and survival percentage (83.51%). The maximum values for seedling growth parameters were also obtained with M_2 , including shoot length (39.39 cm), root length (28.12 cm), total seedling length (67.51 cm), fresh weight (18.35 g), dry weight (3.30 g) and number of leaves per seedling (71.27). The M_2 medium was statistically superior to all other growing media. In contrast, the minimum values for the germination and seedling growth parameters were consistently observed under M_0 – Sand + Soil (1:1).

Keywords: *Moringa*, Cocopeat, Vermicompost, Germination

Introduction

Drumstick (*Moringa oleifera* Lamk.) is an important perennial tree vegetable belonging to the family Moringaceae and possesses a chromosome number of $2n = 28$. It is widely recognized for its economic and nutritional value due to its rapid growth, capacity for nitrogen fixation, and high tolerance to drought conditions. The crop is native to North-Western India and is extensively grown in the Middle East and various tropical regions for its edible pods, seeds, and leaves. Drumstick is commonly known by different regional names, including ‘Ganigana’, ‘Mullakkai’, ‘Murrugi’, ‘Sahjan’ and ‘Muringa’. The tender pods are frequently used in South Indian culinary preparations such as sambhar and pickles, while the flowers and young leaves are consumed as leafy vegetables. In addition, roasted or fried seeds are eaten as snacks and the leaves and twigs are utilized as nutritious fodder for livestock (Bishnoi *et al.*, 2024).

In India, drumstick is grown commercially on a large scale, particularly in Tamil Nadu, where the southern region serves as the principal production hub. India is regarded as the leading producer of drumstick in the world. The crop is highly valued for the unique taste of its tender pods and possesses greater yield potential compared to several other minor vegetable crops. Nevertheless, drumstick cultivation is relatively limited in

central parts of India, suggesting significant scope for expanding its production in these regions. India ranks as the largest producer of drumstick in the world due to the crop's wide adaptability and high economic importance. At the national level, drumstick is grown over an estimated area of nearly 93,916 acres, producing around 1.3 million tons annually. The principal producing states include Andhra Pradesh, Tamil Nadu, and Karnataka, with Andhra Pradesh occupying the leading position in terms of both cultivated area and production, followed by Tamil Nadu and Karnataka, indicating the predominance of drumstick cultivation in the southern regions of the country. In Chhattisgarh, drumstick, locally known as Sahjan, is cultivated in several districts such as Bastar and Bilaspur. Although comprehensive state-level statistics are not fully documented in national databases, district-level information confirms its regular cultivation and contribution to local agricultural production.

Drumstick (*Moringa oleifera* Lamk.), widely referred to as the "Miracle Tree," is highly regarded for its remarkable nutritional and medicinal value. The plant supplies essential amino acids and minerals required for maintaining both human and animal health. Its fresh leaves contain a high level of crude protein (19.3–26.4%), making them a valuable source of feed for livestock (Sahoo *et al.*, 2021) [1]. Moreover, the leaves are exceptionally rich in nutrients, containing vitamin C levels seven times higher than oranges, calcium and protein levels four and two times greater than milk, respectively, potassium content three times that of bananas, iron three times higher than Indian spinach, and vitamin A content four times greater than carrots (Anonymous, 2024) [2]. Due to its rich nutritional composition, drumstick has significant potential in combating malnutrition, which remains a serious issue in states such as Madhya Pradesh, where infant mortality rates are comparatively high. Recognizing its benefits, the government has initiated programs to improve the availability of drumstick to malnourished children in the region. *Moringa* is a nutrient-responsive crop and requires balanced nutrition for sustained vegetative growth, leaf biomass production, and pod yield. Nitrogen plays a crucial role in leaf production and protein synthesis, phosphorus supports root growth and flowering, potassium enhances pod quality and stress tolerance, while micronutrients such as iron and zinc are essential for chlorophyll synthesis and enzymatic activities. Integrated nutrient management involving organic manures and inorganic fertilizers has been shown to improve yield, nutrient uptake, and quality of *Moringa* produce (ICAR, 2020) [3].

The use of farmyard manure (FYM), vermicompost and NPK fertilizers has been reported to improve soil fertility, enhance nutrient availability, and support vigorous plant growth. Studies have indicated that the combined application of FYM and vermicompost along with NPK fertilizers significantly increases plant height, number of branches, and leaf area index in okra, while also improving fruit yield and pod quality (Manju *et al.*, 2019) [4]. The balanced integration of organic manures with chemical fertilizers plays an important role in maintaining sustainable soil fertility, enhancing nutrient use efficiency and ultimately leading to improved crop productivity and quality. The successful cultivation of drumstick largely depends on proper seed germination and the development of vigorous seedlings. Germination is influenced by various factors, including seed quality, availability of moisture, temperature conditions, and the nature of the growing medium. Among these factors, the selection of an appropriate growing medium plays a crucial role, as it affects aeration, moisture retention, and nutrient supply to emerging seedlings. Furthermore, different drumstick cultivars may exhibit varied responses to different growing media due to differences in their physiological traits.

PKM-1 and PKM-2 are improved, high-yielding drumstick cultivars recognized for their better pod quality, while local cultivars are usually well adapted to specific regional environments but often exhibit variability in germination and early seedling growth. Studying the effects of different growing media on these cultivars can help identify the most appropriate nursery management practices, improve germination percentage, enhance seedling vigor, and ensure uniform crop establishment in the field. Hence, the present study aims to assess the

influence of various growing media on the germination and early growth performance of PKM-1, PKM-2 and local drumstick cultivars, with the objective of generating practical recommendations for efficient nursery management and sustainable drumstick cultivation. Due to its high yield potential, rich nutritional composition, medicinal value and ability to adapt to varied agro-climatic conditions, *Moringa* is increasingly recognized as an important crop for ensuring nutritional security, promoting sustainable agriculture, and supporting climate-resilient farming systems. Its significant potential in combating hidden hunger and enhancing farmers' livelihoods has attracted growing attention from researchers and policymakers across the world.

Materials and methods

A nursery experiment entitled "Influence of growing media on germination of PKM-1, PKM-2 and Local Cultivars of *Moringa oleifera*" was conducted during the Rabi season of 2025–26 at the Department of Horticulture Nursery, College of Horticulture and Research Station, Sankara-Patan, Durg, (C.G.). The experiment was laid out in Factorial Completely Randomized Design (FCRD) with three replications. The experiment consisted of twelve treatment combinations involving three cultivars and four growing media. The cultivars were V₁ – PKM-1, V₂ – PKM-2 and V₃ – Local Cultivar, while the growing media were M₀ – Sand + Soil (1:1), M₁ – Sand + Soil + Cocopeat (1:1:2), M₂ – Sand + Soil + Vermicompost (1:1:2) and M₃ – Sand + Soil + FYM (1:1:2). The twelve treatment combinations were T₁ – V₁M₀ (PKM-1 + Sand + Soil, 1:1), T₂ – V₁M₁ (PKM-1 + Sand + Soil + Cocopeat, 1:1:2), T₃ – V₁M₂ (PKM-1 + Sand + Soil + Vermicompost, 1:1:2), T₄ – V₁M₃ (PKM-1 + Sand + Soil + FYM, 1:1:2), T₅ – V₂M₀ (PKM-2 + Sand + Soil, 1:1), T₆ – V₂M₁ (PKM-2 + Sand + Soil + Cocopeat, 1:1:2), T₇ – V₂M₂ (PKM-2 + Sand + Soil + Vermicompost, 1:1:2), T₈ – V₂M₃ (PKM-2 + Sand + Soil + FYM, 1:1:2), T₉ – V₃M₀ (Local Cultivar + Sand + Soil, 1:1), T₁₀ – V₃M₁ (Local Cultivar + Sand + Soil + Cocopeat, 1:1:2), T₁₁ – V₃M₂ (Local Cultivar + Sand + Soil + Vermicompost, 1:1:2) and T₁₂ – V₃M₃ (Local Cultivar + Sand + Soil + FYM, 1:1:2). Observations on germination parameters such as days to first germination, days to 50% germination, germination percentage, speed of germination and survival percentage were recorded. Seedling growth parameters including shoot length, root length, total seedling length, fresh weight, dry weight and number of leaves per seedling were also recorded. The data obtained from the experiment were statistically analyzed to determine the significance of the effects of cultivars, growing media and their interaction.

Results and discussions

Germination parameters

Germination parameters of *Moringa viz.*, days to first germination, days to 50% germination, germination percentage, speed of germination and survival percentage showed significant variation among cultivars, growing media and their interaction. Among the cultivars, V₂ – PKM-2 was found to be the most effective cultivar, recording the earliest first germination (3.89 days), earliest 50% germination (5.05 days), highest germination percentage (90.54%), maximum speed of germination (18.19) and highest survival percentage (82.39%). In contrast, V₃ – Local Cultivar recorded the poorest performance for most germination parameters. Among the growing media, M₂ – Sand + Soil + Vermicompost (1:1:2) recorded the best performance, with minimum days to first germination (3.66 days), minimum days to 50% germination (4.76 days), maximum germination percentage (91.76%), highest speed of germination (18.91) and maximum survival percentage (83.51%). The lowest performance was generally observed under M₀ – Sand + Soil (1:1). At the interaction level, V₂M₂ – PKM-2 + Sand + Soil + Vermicompost (1:1:2) was the most effective combination, recording the minimum days to first germination (1.82 days), minimum days to 50% germination (2.38 days), maximum germination (93.97%), highest speed of germination (20.23) and maximum survival percentage (85.51%). The poorest performance

was generally observed under V₃M₀ – Local Cultivar + Sand + Soil (1:1).

Seedling growth parameters

Seedling growth parameters of *Moringa* viz., shoot length, root length, total seedling length, fresh weight, dry weight and number of leaves per seedling were significantly influenced by cultivars, growing media and their interaction. Among the cultivars, V₂ – PKM-2 recorded the highest shoot length (37.87 cm), root length (27.04 cm), total seedling length (64.92 cm), fresh weight (17.64 g), dry weight (3.18 g) and number of leaves per seedling (69.45). The lowest values for these growth parameters were generally recorded under V₃ – Local Cultivar. Among the growing media, M₂ – Sand + Soil +

Vermicompost (1:1:2) produced the highest shoot length (39.39 cm), root length (28.12 cm), total seedling length (67.51 cm), fresh weight (18.35 g), dry weight (3.30 g) and number of leaves per seedling (71.27). The minimum values were recorded under M₀ – Sand + Soil (1:1). At the interaction level, V₂M₂ – PKM-2 + Sand + Soil + Vermicompost (1:1:2) recorded the highest shoot length (42.12 cm), root length (30.07 cm), total seedling length (72.19 cm), fresh weight (19.62 g), dry weight (3.53 g) and number of leaves per seedling (74.55). The lowest values were generally recorded under V₃M₀ – Local Cultivar + Sand + Soil (1:1). The improved seedling growth under V₂M₂ may be attributed to the combined effect of the superior genetic potential of PKM-2 and the favorable physical, chemical and biological properties of vermicompost.

Table 1. Effect of growing media and cultivars on days of first germination, days of 50% germination, germination (%), speed of germination, survival percentage, shoot length, root length, total seedling length, fresh weight, dry weight and number of leaves of seedling of *Moringa* (*Moringa oleifera*).

Treatment details	Days of first germination	Days of 50% germination	Germination (%)	Speed of germination	Survival percentage	Shoot length (cm)	Root length (cm)	Total seedling length (cm)	Fresh weight of seedling (g)	Dry weight of seedling (g)	Number of leaves per seedling
Factor A : Varieties - 3											
V ₁ - PKM-1	5.10	6.63	87.32	16.27	79.46	33.88	24.19	58.07	15.78	2.84	64.66
V ₂ - PKM-2	3.89	5.05	90.54	18.19	82.39	37.87	27.04	64.92	17.64	3.18	69.45
V ₃ - Local Cultivar	5.77	7.51	85.08	14.94	77.43	31.10	22.21	53.31	14.49	2.61	61.33
SEm (±)	0.32	0.41	1.17	0.70	1.07	1.45	1.04	2.49	0.68	0.12	1.74
CD (5%)	0.93	1.21	3.44	2.05	3.13	4.26	3.04	7.31	1.99	0.36	5.11
Factor B : Growing Media - 4											
M ₀ - Sand + Soil (1:1)	6.67	8.67	82.36	13.32	74.95	27.73	19.80	47.53	12.92	2.32	57.28
M ₁ - Sand + Soil + Cocopit (1:1:2)	4.40	5.72	89.48	17.56	81.43	36.56	26.11	62.67	17.03	3.07	67.87
M ₂ - Sand + Soil + Vermicompost (1:1:2)	3.66	4.76	91.76	18.91	83.51	39.39	28.12	67.51	18.35	3.30	71.27
M ₃ - Sand + Soil + FYM (1:1:2)	4.96	6.44	86.99	16.07	79.16	33.46	23.89	57.35	15.59	2.81	64.15
SEm (±)	0.37	0.48	1.35	13.32	1.23	1.68	1.20	2.87	0.78	0.14	2.01
CD (5%)	1.08	1.40	3.97	17.56	3.61	4.92	3.51	8.44	2.29	0.41	5.91
Interaction effect											
V ₁ M ₀	6.16	8.01	81.96	13.08	74.58	27.23	19.44	46.67	12.69	2.28	56.68
V ₁ M ₁	5.52	7.18	93.91	20.19	85.46	42.06	30.02	72.08	19.54	3.49	74.45
V ₁ M ₂	4.27	5.55	92.81	19.54	84.46	40.69	29.05	69.74	18.95	3.41	72.83
V ₁ M ₃	4.46	5.80	80.54	12.23	73.29	25.47	18.18	43.65	11.86	2.14	54.56
V ₂ M ₀	5.99	7.79	85.29	15.06	77.62	31.37	22.40	53.77	14.61	2.63	61.64
V ₂ M ₁	2.11	2.74	89.97	17.85	81.87	37.16	26.53	63.69	17.31	3.11	68.60
V ₂ M ₂	1.82	2.38	93.97	20.23	85.51	42.12	30.07	72.19	19.62	3.53	74.55
V ₂ M ₃	5.62	7.31	92.94	19.62	84.57	40.84	29.16	70.00	19.03	3.43	73.01
V ₃ M ₀	7.85	10.20	79.84	11.81	72.65	24.60	17.56	42.16	11.46	2.06	53.52
V ₃ M ₁	5.85	7.61	84.51	14.60	76.91	30.39	21.70	52.09	14.16	2.55	60.47
V ₃ M ₂	4.60	5.98	88.51	16.98	80.54	35.35	25.24	60.59	16.47	2.96	66.42
V ₃ M ₃	4.79	6.23	87.48	16.36	79.61	34.07	24.33	58.40	15.87	2.86	64.89
SEm (±)	0.63	0.83	2.34	1.39	2.13	2.90	2.07	4.98	1.35	0.24	3.48
CD (5%)	1.86	2.42	6.88	4.09	6.26	8.52	6.09	14.61	3.97	0.71	10.23

Conclusion

The results revealed that among the cultivars, V₂ – PKM-2 recorded the earliest first germination (3.89 days), earliest 50% germination (5.05 days), highest germination percentage (90.54%), maximum speed of germination (18.19), highest survival percentage (82.39%), maximum shoot length (37.87 cm), root length (27.04 cm), total seedling length (64.92 cm), fresh weight (17.64 g), dry weight (3.18 g) and number of leaves per seedling (69.45), which was significantly superior over the other cultivars. Among the growing media, M₂ – Sand + Soil + Vermicompost (1:1:2) recorded the earliest first germination (3.66 days), earliest 50% germination (4.76 days), highest germination percentage (91.76%), maximum speed of germination (18.91), highest survival percentage (83.51%), maximum shoot length (39.39 cm), root length (28.12 cm), total seedling length (67.51 cm), fresh weight (18.35 g), dry weight (3.30 g) and number of leaves per seedling (71.27), which was statistically superior to all other growing media. The lowest values for all germination and seedling growth parameters were recorded under M₀ – Sand + Soil (1:1). Thus, the combination of PKM-2 with Sand + Soil + Vermicompost (1:1:2) was found to be the most suitable for producing healthy, vigorous and high-quality moringa seedlings under nursery conditions.

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