EFFECT OF GROWING MEDIA ON GERMINATION AND SEEDLING GROWTH OF FOUR DIFFERENT VARIETIES OF TOMATO (*Solanum lycopersicum* (L.)) IN KHUMALTAR LALITPUR, India

ABSTRACT

Aims: Food security is one of the global challenges in this developing world, and the quality of seedlings influences the overall production of vegetables. Thus, the core objective of the study was to determine the impact of various growing media on high-quality seedling production and to analyze whether these media were variety-specific or not.
Study Design: A two-factor factorial experiment using a completely randomized design (CRD) was conducted to assess the interaction effects of both factors.
Place and duration of study: The experiment was conducted at the seedling production greenhouse of Vegetable Crops Development Centre-Khumaltar Lalitpur, Nepal in March, 2023.
Methodology: Six different combinations of growing media: soil, sand + soil + FYM, sand + soil + vermicompost, coco peat, coco peat + FYM, and coco peat + vermicompost, and four different varieties of tomato: Srijana, Khumal-2, Khumal-3 and Monoprecos were tested in a two-factor factorial in a completely randomized design (CRD) with three replications for each combination of treatments.
Results: The results of this experiment revealed that seeds of all varieties of tomato on coco peat and vermicompost were successful for better seedling growth and seedling health. Also, growing media with coco peat led to a higher germination percentage (72.92%), lower mean germination time (8.922 days), and higher speed of germination (1.745). Coco peat + vermicompost showed superior seedling growth parameters, including shoot length (7.852 cm), root length (7.123 cm), root to shoot ratio (1.161), dry weight (0.1781 g), fresh weight (1.483 g), and dry matter accumulation (12.90%). Among the varieties, Monoprecos exhibited the highest germination percentage (66.1%) and seed vigor index (933.8), although it had the highest mean germination time (10.26 days). Shoot length, speed of germination, root length, and root to shoot ratio were statistically similar among varieties. Fresh and dry weights were higher in the Srijana variety, while dry matter accumulation did not vary significantly among varieties.
Conclusion: Vermicompost in the presence of coco peat has a significant impact on the germination and growth of tomato seedlings. No variety-specific growing media was recommended for seedling production in tomatoes. Based on the results, it is recommended to explore the effect of different compositions of vermicompost on tomato seedlings for healthy seedling production.

Key words: Growth, Coco peat, Vermicompost, Seedling

1. INTRODUCTION

In Nepal, 65.7 % of the total population is involved in some type of agriculture, which contributes 26.26 % to the national GDP where the vegetable sector shares 19.44 % of AGDP [1]. The area and production of vegetables in Nepal are 284,121 ha and 3,993,167 mt respectively with

productivity of 14.01 Mt/ha [2]. Among the various vegetable crops grown in the world, tomato is one of the most economically important solanaceous crops [3]. The demand for this crop is increasing in the world due to its multiple uses as second most important horticultural crop in terms of yield [4]. The crops can be used directly as vegetables or salads or after processing in making ketchup, pickles, and sauces [5].

Tomato (*Lycopersicon esculentum L.*) is a vegetable crop of the *solanaceous* family [6]. It is widely grown around the world and originated from the Andean region of South America and Mexico from the wild ancestor of *Lycopersicon subspecies cerasiforme* [7]. Seedling production is very vital for horticulture production because seedlings influence the overall performance of crops in the field [8]. Growing media influence seed germination and seedling health of crops [9]. Germination of seed is a very critical stage in plant growth, and development and under the regulation of hormones and light [10]. Traditionally, tomato seedlings were raised in the open field nursery with several problems like lower germination, low seedling vigor index, and problems of damping-off of the seedlings resulting in significant seed wastage [11]. In the controlled house production system, seedlings can be raised in plastic pots, Styrofoam plug trays, or plastic trays, and the seedlings that have been raised in plastic trays have a higher germination percentage and seedling establishment rate than those raised in the field nursery [12].

Different types of growing media can be used for tomato seedling production in plastic trays or plastic bags like a mixture of soil, sand or FYM, a mixture of coco peat and vermicompost, and others [13]. Growing seedlings in the artificial medium without soil or compost is the best practice as it prevents the seedlings from soil-borne diseases [14]. The composition of growing media also affects the quality of the seedling [15]. The use of the best-growing substrate for seedling production ensures adequate root system growth, ensures the optimum nutrient exchange capacity, and ensures adequate exchange of gases from the root system [16]. Physical properties of growing media such as pore size and number of pores are determined by media particle size and shape and affect the availability of water and air, ultimately influencing germination and growth of seedlings [17]. Production of seeds of the Shrijana variety of tomato and seedling production and distribution of seedlings at lower prices to the farmers of Lalitpur are the major objectives of VCDC Lalitpur [18].

Lalitpur district is one of the leading tomato-producing districts of Nepal. Demand for fresh tomatoes is increasing in the country. Despite the great potential of production and continuous efforts from the government, tomato growers in this area are facing severe production constraints like low productivity of the tomato varieties, lower establishment rate of tomato seedlings in the field after transplanting, lower germination of the tomato seeds in the field conditions, higher seed wastage and higher seedling mortality seedlings after establishment and poor seedling health of tomato seedlings in field and tray condition. Tomato crops need good nursery establishment and healthy seedlings.

Improved crop variety and quality seeds are the most viable way to improve agricultural production and food security in a sustainable manner. Growing medium influences the germination of seeds, length and girth of seedlings, seedlings health, root length, seedling vigor, etc. [19]. Vermicompost and coco peat provide adequate nutrients necessary for the development of seedlings and enhance the physical and biological properties of soil by decreasing compactness and increasing porosity of the medium, which ultimately affect seed germination and seedling health of plants [20]. Growing media properties such as water-holding capacity,

electrical conductivity, ion exchange capacity, bulk density, and nutrient content influence the germination and growth of seedlings [21].

This study helps to identify variety-specific growing media for better seedling production in tomatoes i.e., whether growing media were variety-specific or not.

This study aims to identify whether specific growing media can optimize seedling production for different tomato varieties. By assessing the performance of various growing media on seedling germination and growth parameters, the research seeks to provide insights into improving seedling quality and establishing best practices for tomato cultivation in Nepal.

2. Material and Methods

2.1 Study site

The vegetable Crops Development Center (VCDC) is located at Khumaltar Lalitpur. Lalitpur District, part of Baghmati Province, is one of the seventy-seven districts of Nepal. The district, with Lalitpur as its district headquarters, covers an area of 385 km2 (149 sq. mi). It is a mid-hill district of Nepal, and situated at latitude: 27° 32' 31.0812"N and longitude: 85° 20' 3.4692" E [22]. Out of the total cultivable area, 184 ha has been used for tomato production. The prime function of the VCDC is the production of seeds and seedlings of vegetable crops. The greenhouse of the Vegetable Crops Development Center was purposely selected for the study due to the large-scale production and distribution of vegetable seedlings from the VCDC, as well as the uniform environmental conditions inside the greenhouse for each treatment in the study.

2.2 Experimental Design

An experiment was conducted as a factorial design with two factors based on a Completely Randomized Design (CRD) with three replications for each treatment, which consisted of four varieties of tomato on six different growing media so that the total number of treatments under study was 24. Plug plastic trays of 72-cell capacity were used for sowing of seed. For each treatment ,18 tray cells were used and one column of cells was left empty to distinguish each treatment.

2.3 Treatments details

The experiment was carried out with six different combinations of growing media (i.e. T1: Soil, T2: Soil+ Sand+ FYM, T3: Soil+ Sand+ Vermicompost, T4: Coco peat, T5: Coco peat +FYM, T6: Coco peat + Vermicompost) and four different varieties of tomato (i.e. V1: Srijana, V2: Khumal-2, V3: Khumal-3, V4: Monoprecos). A total of 24 treatments were applied under each replication. Varieties of tomato were selected with the aim of testing the germination percentage and mean germination time of tomato seeds which were produced in farms of vegetable crop development centers.

2.4 Plan of Work

First of all, plastic trays were sterilized with the help of sodium hypochlorite to kill the harmful pathogens present in it. Then, coco peat was soaked in water to break coco peat and soaked coco peat

was squeezed with the help of palm to drain the excess water. The sand was collected and sieved to make fine sand. Each treatment was prepared separately in a uniform way and filled in a plastic tray (18 tray cells were used for each treatment). The seeds were sown directly on a plastic tray and before sowing it was treated with fungicide. A single seed was sown in a tray cell and a total of 18 seeds of single variety was used for each treatment under each replication. Irrigation was done with the help of a rose can twice a day by covering the plastic tray with clean jute sacks till the germination of seeds. After the germination of the seeds, jute sacks were removed from the seedling tray.

2.5 Data collection techniques

Data were collected for the following different parameters:

2.5.1 Germination percentage

To measure the seed germination percentage for each treatment, the total number of seeds that were germinated under each treatment was recorded at 7 days after sowing. Data were collected at intervals of 24 hours every day until completion or cease of germination. The seed germination percentage was calculated by the following equation,

$$\text{Germination percentage (\%)} = \frac{number\ of seeed\ germinated}{total\ number\ of\ seed\ sown} \times 100$$ [23]

2.5.2 Mean Germination Time

Germination of seeds was observed regularly every 24 hours. After termination of germination mean germination time was calculated by:

$$\text{MGT} = \sum \frac{n \times d}{N}$$ [24]

Where n number of seeds germinated on each day

d= number of days from the beginning of the experiment

N Total number of seeds germinated at termination of experiments.

2.5.3 Speed of germination

The number of seedling germination was counted regularly with general inspection from the day of planting till the time of complete germination or cease of germination of seed. The days to each germination were noted, and the speed of germination was calculated for each treatment by using the following equation,

$$\text{Speed of germination} = \frac{n1}{d1} + \frac{n2}{d2} + \cdots$$ [25]

Where, n = number of germinated seeds, d= number of days from sowing of seed

2.5.4 Seedling vigor index

The seedling vigor index was calculated by,

Seedling vigor index = Germination (%) × (Shoot length +Root length) [26]

2.5.5 Seedling height

Seedling heights were measured with the help of a 30 cm scale from the base to the terminal leaf of the sample plant for each replication, seedling heights were counted from one week of germination up to 28 days after sowing at a 7-day interval.

2.5.6 Root length and shoot length ratio

After 28 days of seed sowing, root and shoot length was measured and noted. Root length and shoot length ratio were determined by,

$$\text{Root to shoot length ratio} = \frac{Length\ of\ root}{Length\ of\ shoot}$$

2.5.7 Fresh and dry weight

Sample plants were uprooted after 28 days and fresh weight was noted then plant samples were subjected to oven drying for 24 hours at 105 ℃ and dry weight was noted.

2.5.8 Dry matter accumulation

After the determination of fresh and dry weight of sample plants, dry matter accumulation was determined by using,

$$\text{Dry matter accumulation (\%)} = \frac{Dry\ weight}{Fresh\ weight} \times 100$$

2.6 Statistical Analysis

Obtained data were arranged and tabulated in Microsoft Excel. All data were analyzed statistically by using Gen Stat 15th edition. Data were subjected to Analysis of variance and Duncan's Multiple range test (DMRT) was used for mean comparison at a 5% level of significance and interpretation was done.

3. RESULTS

3.1 Germination

Germination percentage, mean germination time, and speed of germination were tested on different treatments. There was a significant difference in germination percentage among the different growing media at the 5% and 1% levels of significance. The highest mean germination percentage was recorded in coco peat (72.92), which was statistically on par with coco peat + FYM (67.50), and coco peat + vermicompost (65). This was followed by soil + sand + vermin compost (59.17) and soil + sand + FYM (50.42), while the minimum germination percentage was recorded in soil media (41.67) as shown in Table 1. Similarly, there were significant difference in germination percentage among the different varieties at the 5% and 1% levels of significance. Among varieties, the highest germination percentage was found in the Monoprecos variety (66.1), whereas the germination percentages of other varieties, i.e., Srijana, Khumal-2, and Khumal-3, were statistically on par. Similarly, the interaction between variety and growth media showed non-significant results.

There was a significant difference in mean germination time among the different growing media at the 5% and 1% levels of significance. Growing media with coco peat resulted in a lower mean germination time (8.922 days), which was statistically on par with coco peat + vermicompost (8.973), coco peat + FYM (9.094), and soil + sand + vermicompost (9.324). A higher mean germination time was found in growing media containing soil, sand, and FYM (10.882), which was statistically on par with soil media (10.392). Similarly, there were significant difference in mean germination time among different varieties. The variety Khumal-2 with a lower mean germination time (9.01) was statistically on par with the mean germination time of Srijana (9.55) and Khumal-3 (9.55), while a higher mean germination time was found in the Monoprecos variety (10.26 days). The interaction between growing media and varieties had no significant impact on mean germination time.

There was a significant difference in the speed of germination among different growing media at the 5% and 1% levels of significance. The maximum speed of germination was recorded in media with coco peat (1.745), which was statistically on par with coco peat + FYM (1.560) and coco peat + vermicompost (1.554), followed by soil + sand + vermicompost (1.362). The lowest speed of germination was found in soil media (0.913), which was statistically on par with soil + sand + FYM (1.058). However, non-significant results were found for the speed of germination among different varieties. The interaction between varieties and growth media showed non-significant results for the speed of germination.

Table 1. Germination percentage, Mean germination time, and Speed of germination as influenced by different growing media on four different varieties of Tomato in Lalitpur, Nepal

Treatment	Germination Percentage	Mean Germination time	Speed of Germination
Growing Media			
Soil	41.67^{d}	10.392^{b}	0.913^{c}
Soil + Sand + FYM	50.42^{c}	10.882^{b}	1.058^{c}
Soil + Sand + Vermicompost	59.17^{b}	9.324^{a}	1.362^{b}
Coco peat	72.92^{a}	8.922^{a}	1.745^{a}
Coco peat +FYM	67.50^{a}	9.094^{a}	1.560^{a}
Coco peat + Vermicompost	65^{ab}	8.957^{a}	1.554^{a}
sem±	2.74	0.248	0.0654
LSD	7.80	0.706	0.1859
F probability	<0.001**	<0.001**	<0.001**
Varieties			
Srijana	59.7^{b}	9.55^{a}	1.372
Khumal-2	56.9^{b}	9.01^{a}	1.406
Khumal-	55^{b}	9.55^{a}	1.271
3	66.1^{a}	10.26^{b}	1.413
Monoprecos	2.24	0.203	0.0534
sem±	6.37	0.576	
LSD $_{(0.05)}$	0.004**	<0.001**	ns
F probability			
Growing Media* Variety (F probability)	ns	ns	ns
% CV	16	9	16.6
Grand Mean	59.4	9.60	1.365

Note- LSD: Least significant difference, Sem: Standard error of means, CV: Coefficient of variance. * Denotes significance at 5% level, ** denotes significance at 1% level, ns: denotes non-significance.

3.2 Shoot Length

Shoot length at 14, 21, and 28 DAS was tested on different treatments, and the following results were obtained. There were significant difference in seedling shoot length at 14 DAS, 21 DAS, and 28 DAS among different growing media at the 5% and 1% levels of significance. Significant differences were also observed in seedling shoot length among the varieties at 14 DAS, but at 21 and 28 DAS, the results were non-significant at the 5% and 1% levels of significance. Seedlings in tray cells also showed significant interaction between varieties and growing media at 14 DAS at the 5% and 1% levels of significance (Table 2), but the interaction was non-significant at 21 and 28 days after sowing.

At 14 DAS, the maximum seedling shoot length was found in the growing medium with coco peat + vermicompost (2.688), which was statistically on par with coco peat + FYM (2.682)

and coco peat only (2.576). The lowest seedling shoot length was found in media with soil + sand + FYM (1.195), which was statistically on par with soil media (2.290). When the varieties were tested, the highest seedling shoot length was found in Khumal-2 (2.687), followed by Srijana (2.384), which was statistically on par with the shoot length of Khumal-3 (2.374). The lowest shoot length was found in the Monoprecos variety (2.201). Similarly, a significant interaction was found between variety and growing media. All varieties except Khumal-2 showed higher mean shoot length in coco peat + vermicompost medium, but the variety Khumal-2 showed the highest shoot length in the coco peat + FYM medium.

At 21 DAS, the maximum seedling shoot length was found in growing medium with coco peat + vermicompost (5.372), followed by coco peat + FYM (4.938), which was statistically on par with soil + sand + vermicompost. The lowest seedling shoot length was observed in soil media (4.169), which was statistically on par with coco peat media (4.495). Non-significant results were found for seedling shoot length among different varieties.

At 28 DAS, the maximum seedling shoot length was observed in the medium with a mixture of coco peat + vermicompost (7.852). This was followed by coco peat + FYM (7.147), which was statistically on par with soil + sand + vermicompost (7.013) and soil + sand + FYM (6.619). The minimum seedling shoot length was found in soil media (6.02), which was statistically on par with coco peat only (6.09). There were no significant differences observed among different varieties.

Table 2. Seedling Shoot length at 14 DAS, 21 DAS, and 28 DAS as influenced by different growing media on four different varieties of tomato in Lalitpur, Nepal.

Treatments	14DAS	21 DAS	28 DAS
Growing Media			
Soil	2.290^{b}	4.169^{d}	6.02^{c}
Soil + Sand + FYM	1.195^{b}	4.531^{c}	6.619^{bc}
Soil + Sand + Vermicompost	2.290^{b}	4.928^{b}	7.013^{b}
Coco peat	2.576^{a}	4.495^{cd}	6.090^{c}
Coco peat +FYM	2.682^{a}	4.938^{b}	7.147^{b}
Coco peat + Vermicompost	2.688^{a}	5.372^{a}	7.852^{a}
sem±	0.0575	0.1149	0.0654
LSD	0.1636	0.3268	0.6840
F value	$<0.001^{**}$	$<0.001^{**}$	$<0.001^{**}$
Varieties			
Srijana	2.384^{b}	4.472	6.980
Khumal-2	2.687^{a}	4.431	6.618
Khumal-3	2.374^{b}	4.237	6.531
Monoprecos	2.201^{c}	4.523	7.186
sem±	0.0470	0.0939	0.1964
$LSD_{(0.05)}$	0.1336		
F value	$<0.001^{**}$	0.174^{ns}	0.075^{ns}
Growing Media* Variety (F value)	$<0.001^{**}$	0.263^{ns}	0.612^{ns}
% CV	8.3	8.4	12.2
Grand Mean	2.412	4.739	6.829

Note- LSD: Least significant difference, Sem: Standard error of means, CV: Coefficient of variance. * Denotes significance at 5% level, ** denotes significance at 1% level, ns denotes non-significance.

3.3 Root Length, Root length and Shoot length ratio, and Seed Vigor Index

Root length, root length to shoot length ratio, and seed vigor index were tested across different treatments, and the following results were obtained.

There was a significant difference in the seedling root length (28 DAS) among different growing media at the 5% and 1% levels of significance. Maximum root length was observed in growing media with coco peat + vermicompost (7.123), which was statistically on par with the root length of soil + sand + vermicompost media (6.845) and coco peat + FYM (6.774). The minimum root length was observed in soil media (5.875), which was statistically on par with soil + sand + FYM (5.986) and coco peat only (6.906) (Table 3). Non-significant results were found for root length among different varieties. A significant interaction was found between varieties and different growing media for the root length of seedlings.

There was a significant difference in the seedling root-to-shoot length ratio (28 DAS) among different growing media at the 5% and 1% levels of significance. The maximum root length to shoot length ratio was observed in coco peat + vermicompost media (1.161). The lowest ratio was found in soil (0.895), which was statistically on par with soil + sand + vermicompost (0.981), coco peat + FYM (0.957), and coco peat only (0.923), as shown in Table 3. The results across varieties across in growing media were non-significant at the 5% and 1% levels of significance. The interaction between variety and different growing media had non-significant results at the 5% and 1% levels of significance.

There was a significant difference in the seed vigor index among the different growth media at the 5% and 1% levels of significance. The highest seed vigor index was found in coco peat + vermicompost (973), which was statistically on par with coco peat (964) and coco peat + FYM (942). This was followed by soil + sand + vermicompost (822), which was statistically on par with coco peat + FYM (942). The minimum seed vigor index was observed in soil (524), which was statistically on par with sand + soil + FYM (618). Similarly, there was a significant difference in seed vigor index among the varieties at the 5% and 1% levels of significance. When varieties were tested individually across the growing media, the highest seed vigor index was found in Monoprecos (933.8), whereas the seed vigor index of the other three varieties was statistically on par (Table 3). The interaction between variety and different growing media had non-significant results at the 5% and 1% levels of significance.

Table 3. Mean Root length (28DAS), Root-to-shoot length ratio (28DAS), and Seed vigor index as influenced by different growing media on four different varieties of tomato in Lalitpur, Nepal.

Treatment	Root length (28 DAS)	Root to Shoot ratio (28 DAS)	Seed Vigor Index
Growing Media			
Soil	5.875^{b}	0.895^{b}	524^{c}
Soil + Sand + FYM	5.986^{b}	0.964^{b}	618^{c}
Soil + Sand + Vermicompost	6.845^{a}	0.981^{b}	822^{b}
Coco peat	6.096^{b}	0.923^{b}	964^{a}
Coco peat +FYM	6.774^{a}	0.957^{b}	942^{ab}
Coco peat + Vermicompost	7.123^{a}	1.161^{a}	973^{a}
sem±	0 1902	0.0373	43.0
LSD	0.5409	0.1059	122.4
F Probability	<0.001**	<0.001**	<0.001**
Varieties			
Srijana	6.617	0.953	816.6^{b}
Khumal-2	6.586	1.009	760.6^{b}
Khumal-3	6.566	1.026	717.7^{b}
Monoprecos	6.658	0.932	933.8^{a}
sem±	0.1553	0.0304	35.1
LSD $_{(0.05)}$			99.9
F value	0.977^{ns}	0.105^{ns}	<0.001**
Growing Media* Variety (F probability)	0.008**	0.527^{ns}	0.286^{ns}
% CV	10	13.2	18.5
Grand Mean	6.670	0.980	807

Note- LSD: Least significant difference, Sem: Standard error of means, CV: Coefficient of variance. * Denotes significance at 5% level, ** denotes significance at 1% level, ns denotes non-significance.

3.4 Fresh weight of seedling, Dry weight of seedling, Dry Matter Accumulation (%)

Fresh weight, Dry weight, and Dry Matter Accumulation % were tested across the different treatments and the following results were obtained:

There were significant differences found in the fresh weight of seedlings among different growing media at the 5% and 1% levels of significance. The highest seedling fresh weight was found in coco peat + vermicompost (1.483), this was followed by coco peat + FYM (1.297), which was statistically on par with soil + sand + vermicompost (1.194). The minimum seedling weight was found in coco peat (0.763), which was statistically at par with soil media (0.780) (Table 4). Similarly, there were significant differences found in fresh weight among different varieties at the 5% and 1% significance levels. When varieties were tested individually across the growing media, the maximum seedling fresh weight was found in Khumal-2 variety (1.156), which was statistically on par with Monoprecos (1.143) and Srijana (1.230). The minimum seedling fresh weight was recorded in Khumal-3 (0.978) (Table 4). The interaction between varieties and different growing media also had significant results at the 5% and 1% levels of significance (Table 4).

There were significant differences found in the dry weight of seedlings among different growing media at the 5% and 1% levels of significance. The highest mean seedling dry weight was found in coco peat + vermicompost (0.1781), followed by coco peat + FYM (0.1418), which was statistically on par with soil + sand + vermicompost (0.1380). The lowest mean seedling dry weight was found in growing media with coco peat (0.0631), which was statistically on par with the dry weight of soil (0.079) (Table 4). Similarly, there were significant differences found in the dry weight of seedlings among different varieties at the 1% and 5% levels of significance (Table 4). When varieties were tested individually across the different growing media, the maximum mean seedling dry weight was recorded in Srijana (0.1378), whereas the dry weight of the other three varieties was statistically on par (Table 4). The interaction between growing media and different varieties showed non-significant results.

There were significant differences in dry matter accumulation percentage of the seedlings among different growing media at the 5% and 1% levels of significance. The highest mean dry matter accumulation percentage was found in coco peat + vermicompost (12.90), followed by soil + sand + vermicompost (11.79), which was statistically on par with coco peat + FYM (10.95), sand + soil + FYM (10.90), and soil only (10.23). The lowest dry matter accumulation was recorded in the growing media with coco peat (8.20) (Table 4). However, the results for varieties across the growing media were non-significant in terms of seedling dry matter accumulation. The interaction between growing media and different varieties also had non-significant results.

Table 4. Mean fresh and dry weight of seedling and Dry matter accumulation (%) as influenced by different growing media on 4 different varieties of tomato in Lalitpur, Nepal.

Treatment	Fresh Weight of Seedling	Dry weight of Seedling	Dry matter Accumulation (%)
Growing Media			
Soil	0.780[d]	0.079[d]	10.23[b]
Soil + Sand + FYM	0.991[c]	0.1030[c]	10.90[b]
Soil + Sand + Vermicompost	1.194[b]	0.1380[b]	11.79[b]
Coco peat	0.763[d]	0.0631[d]	8.20[c]
Coco peat +FYM	1.297[b]	0.1418[b]	10.95[b]
Coco peat + Vermicompost	1.483[a]	0.1781[a]	12.90[a]
sem±	0.0564	0.00595	0.651
LSD	0.1603	0.01692	1.850
F probablity	<0.001[**]	<0.001[**]	0.004[**]
Varieties			
Srijana	1.230[a]	0.1378[a]	11.50
Khumal-2	1.156[a]	0.1228[b]	11.34
Khumal-3	0.978[b]	0.1118[b]	11.90
Monoprecos	1.143[a]	0.1221[b]	11.19
sem±	0.0460	0.00486	0.531
LSD $_{(0.05)}$	0.1309	0.01381	
F probability	0.003[**]	0.005[**]	0.804[ns]
Growing Media* Variety (F pr.)	0.002[**]	ns	ns
% CV	17.3	16.7	19.6
Grand Mean	1.127	0.1236	11.48

Note- LSD: Least significant difference, Sem: Standard error of means, CV: Coefficient of variance. * Denotes significance at 5% level, ** denotes significance at 1% level, ns denotes non-significance.

4. DISCUSSION

Germination percentage, mean germination time, speed of germination vary across the treatments. The higher germination percentage and the higher speed of germination in coco peat are due to its adequate porosity and water-holding capacity [27]. According to Zaller, (2007); the application of vermicompost significantly affects the germination of seeds which supports our findings. Germination percentage was positively affected by the use of fertilizer, and the use of suitable growing media, all sources of nutrients have significant impact on the germination of seeds [28]. Coco peat facilitates earlier germination of seed by creating suitable conditions for earlier germination of seeds as by providing proper aeration and moisture for seed germination [29], which supports our findings. Growth media with coco peat, vermicompost, and FYM showed a significant impact due to the combination of all essential factors, which improves the physical, biological, and nutritional quality of the media [30].

Seedling shoot length, root length, root length to shoot length ratio, seed vigor index, and biomass accumulation (fresh and dry weight) of tomato seedlings which indicate the overall quality of the seedling varied significantly across the treatments. Compared to the controlled treatment, considerably all of these parameters were recorded as higher in media containing vermicompost + coco peat which is supported by the higher content of available nutrients in vermicompost and higher porosity and water-holding capacity of coco peat. Higher seedling shoot length resulting from the application of vermicompost might be due to the presence of humic acid, which enhances the soil's physical condition and facilitates the utilization of plant nutrients in tomatoes [31]. The superiority of vermicompost in the growth and development of roots might be due to its better physical structure, which contains a balanced composition of all essential nutrients [32]. Vermicompost helps in better root-to-shoot length ratio by providing nutrients for healthy seedling growth, and improving the physical properties of the growing medium. Similarly, coco peat provides better aeration, high moisture holding capacity, and better root penetration, and in presence of a light source of fertilizer like vermicompost, coco peat helps in better development of roots and shoots of seedlings [33]. The seed vigor index determines the overall health of the seedling and yield of the crops. The higher seed vigor index with coco peat + vermicompost, might be due to its good water holding capacity as well as sufficient porosity, which permits adequate gaseous exchange between the medium and seed and supports seedling growth [34]. The lower seed vigor index in soil may be due to poor drainage, the development of roots might be affected, and results in a high incidence of soil-borne disease [35]. The higher seedling fresh and dry weight and dry matter accumulation (%) in coco peat + vermicompost might be due to its porosity, water holding capacity, and nutrient exchange capacity of the growing medium, which promotes the vigorous growth of roots and helps in better uptake of nutrients ensuring better biomass accumulation [36].

Differences in germination percentage, mean germination time seed vigor index, and fresh and dry weight of seedlings among varieties might be due to quality of seed and genetic factor of the varieties.

5. Conclusion

In conclusion, the results of the current experiment revealed that the tomato seeds grown on coco peat were successful in achieving higher germination percentage, lower mean germination time, and higher speed of germination. Different growth parameters like seedling shoot length, root length, fresh and dry weight of seedlings, dry matter accumulation %, root length, root to shoot ratio, and seed vigor index were higher in Coco peat + Vermicompost and lowest in media with coco peat only which was statistically on par with soil as the control media. Among the varieties germination %, seed vigor index were found to be highest in the Monoprecos variety, and the mean germination time of Srijana, Khumal-2, and Monoprecos were statistically on par. Mean seedling shoot length, root length and root to shoot length ratio did not vary across the varieties. The interaction between varieties and growing media showed a significant impact on root length, fresh weight of seedlings and dry matter accumulation percentage. The above results demonstrate that germination and seedling growth of tomatoes might be differently affected by different growing media and less affected by varieties selected. Growing media treatment was not variety-specific to tomatoes in seedling production, as all the varieties showed higher germination in coco peat and maximum seedling growth in coco peat + vermicompost.

Recommendation to farmers and future researchers.

Based on the findings of the study, some recommendations have been made that could be useful for farmers, and future research, who are involved in the production of tomatoes.

1. The experiment recommends farmers to use vermicompost + coco peat as an effective growing media for quality seedling production on any varieties of tomato.
2. Similar research should be done in different concentrations of vermicompost to evaluate the effect of vermicompost amendments on quality seedling production.

Data availability

All data generated or analyzed during this study are included in this published article.

Disclaimer (Artificial intelligence)

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc have been used during writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology

Details of the AI usage are given below:

1. Grammarly software has been use to correct grammar and to rephrase language.

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