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

ABSTRACT

Aims: Food security is one of the global challenges in this developing world, and the quality of seedling influences the overall production of vegetables~~vegetable~~. Thus, the core objective of the study was to determine the impact of various growing media on quality seedling production, and to analyze whether these media were varieties specific or not.

Study Design: Two-factor factorial completely randomized design (CRD)

Place and duration of study: An 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 completely randomized design (CRD) with three replications for each combination of treatments. ~~The sample seedlings were tagged with help of color thread and different parameters had been studied in controlled condition.~~

Results: ~~The results indicated that 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: ~~Light source of fertilizer like vermicompost in presence of substrate media with coco peat have a significant impact on seedling growth of tomato seedling. No variety specific growing media were recommended for seedling production in tomatoes.~~ Based on the results, it is recommended to explore the effect of different composition of vermicompost on tomato seedling for healthy seedling production.

Key words: Growth, Coco peat, Vermicompost, Seedling

1. INTRODUCTION

In Nepal, 65.7 % of total population is involved in some type of agriculture activities and it 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 is 284,121 ha and 3,993,167mt respectively with

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

Tomato (*Lycopersicon esculentum L*.) is the 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 sub species cerasiforme* [7]. Seedling production is very vital for horticulture production because seedling influences 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 hormone and light [10]. Traditionally, tomato seedlings were raised in the open field nursery with several problems like lower germination, low seedling vigor index, problems of damping off of the seedlings resulting in the~~resulting the~~ wastage of huge amounts of~~amount~~ seed [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 higher percentage of germination and seedling establishment rate than those raised in the field nursery [12].

Different types of growth medium can be used for tomato seedling production in plastic trays~~tray~~ or plastic bags like mixture of soil sand or FYM, mixture of coco peat and vermicompost and others [13]. Growing seedlings in the artificial medium without soil or compost is best practices as it prevents the seedlings from soil borne disease [14]. Composition of growth medium also affects the quality of seedling [15]. Use of the best growing substrate for seedling production ensures an adequate root system growth, ensures the optimum nutrient exchange capacity, and ensures adequate exchange of gasses~~gases~~ from the root system [16].

Physical properties of growing media such as pore size, number of pores are determined by media particle size and shape and affect the availability of water and air ultimately germination and growth of seedlings [17]. Production of seed of Shrijana variety of tomato and seedlings production and distribution of seedlings at lower prices to the farmers of Lalitpur is the major objective 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 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 fields condition, wastage of higher amount of seeds in fields, mortality of tomato seedlings after establishment and poor seedling heat of tomato seedlings in field and tray condition. Tomato crops need good nursery establishment and healthy seedlings.

Seed is the most important determinant of agricultural production potential, on which the efficacy of other agriculture inputs is dependent. 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 germination of seeds, length and girth of seedlings, seedlings health, root length, seedling vigor etc. [19]. Vermi compost and coco peat provide~~provides~~ adequate nutrients necessary for development of seedlings and enhance physical and biological properties of soil by

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decreasing compactness and increasing porosity of medium, which ultimately affect the seed germination and seedling health of plants [20]. A good growing medium provides sufficient support to the plant and it serves as a reservoir of water and essential plant nutrients, it also allows good gaseous exchange in the root zone and helps in root development, seedling establishment and vigor [21]. Growing media properties such as water holding capacity, electrical conductivity, ion exchange capacity, bulk density, nutrient content influence germination and growth of seedlings [22]. Good growing media help in production of quality seedlings, there is a positive relationship between seedling quality and growth and yield performance of tomato [23].

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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

Vegetables crops development center is located at khumaltar Lalitpur. Lalitpur District, part of Bagmati 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 [24]. Out of the total cultivable area, 184 ha has been used for tomato production. Prime function of the vegetables crops development center is the production of seeds and seedlings of vegetables crops. Greenhouse of the vegetables crops development center was purposely selected for the study because production and distribution of a large number of vegetables seedlings from the VCDC and uniform environmental condition inside the greenhouse for each treatment of the study.

2.2 Experimental Design

Experiment was conducted on two factor Completely Randomized Design (CRD) which consists of 4 varieties of tomato on 6 different growing media, so that total number of treatments under study were 24 and for each treatment 3 replication was done. Plug plastic trays of 72 cell capacity were used for growing 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

A total of 24 treatments was done under each replication

Factor -1: Varieties of tomato

V1: Srijana

V2: Khumal-2

V3: Khumal-3

V4: Monoprecos

Varieties of tomato were selected on the aim of testing the germination percentage and mean germination time of tomato seeds which were produced in farms of vegetable crop development centers.

Factor-2: Growing media

T1: Soil (Top soil from VCDC field)

T2: Soil+ Sand+ FYM (1:1:1 on the basis of weight)

T3: Soil+ Sand+ Vermicompost (1:1:1 on the basis of weight)

T4: Coco peat

T5: Coco peat +FYM (1:1 on the basis of weight)

T6: Coco peat + Vermicompost (1:1 on the basis of weight)

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2.4 Layout of the Experiment

T1V1	T1V2	T1V3	T1V4	T2V1	T2V2	T2V3	T2V4
T3V1	T3V2	T3V3	T3V4	T4V1	T4V2	T4V3	T4V4
T5V1	T5V2	T5V3	T5V4	T6V1	T6V2	T6V3	T6V4
T2V1	T2V2	T2V3	T2V4	T4V1	T4V2	T4V3	T4V4
T1V1	T1V2	T1V3	T1V4	T5V1	T5V2	T5V3	T5V4
T6V1	T6V2	T6V3	T6V4	T3V1	T3V2	T3V4	T3V3
T4V1	T4V4	T4V3	T4V2	T6V4	T6V1	T6V3	T6V2
T3V3	T3V2	T3V4	T3V1	T1V4	T1V2	T1V3	T1V1
T2V4	T2V3	T2V2	T2V1	T5V2	T5V3	T5V4	T5V1

2.5 Plan of work

2.5.1 Sterilization of plastic tray

Plastic tray was sterilized with the help of sodium hypochlorite in order to kill the harmful pathogen present on it.

2.5.2 Preparation of growing media

Coco peat was soaked in water in order to break coco peat. And soaked coco peat was seized with the help of palm in order to drain the excess of the water. Sand was collected and sieved in order 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). Between treatments one column of tray cells was left empty in order to distinguish the treatments and tagged.

2.5.3 Sowing of seeds

Seed was sown directly on a plastic tray and before sowing it was treated with fungicide. 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.

2.5.4 Irrigation

Irrigation was done with the help of a rose can twice a day by covering the plastic tray with clean jute sacks till germination of seeds. After germination jute sacks were removed from the seedlings tray.

2.6 Data collection techniques

Data were collected for following different parameters:

2.6.1 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 the interval of 24 hours every day until completion or cease of germination. Seed germination percentage was calculated by following formulae,

Germination percentage (%) = (number of seed germinated)/ (total number of seed sown) ×100

2.6.2 Mean Germination time

Germination of seeds was observed regularly each 24 hours. After termination of germination mean germination time was calculated by using following formulae:

$$MGT = \sum (n \times d)/N \ [25]$$

Where n= number of seed germinated on each day

d= number of days from beginning of experiment

N= Total number of seeds germinated at termination of experiments.

2.6.3 Speed of germination

Speed of germination was calculated for each treatment by using following formulae

Speed of germination = n1/d1+n2/d2+n3/d3+----------

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

2.6.4 Seedling vigor index

Seedling vigor index was calculated by using following formulae,

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

2.5 Seedling height

Seedling heights were measured with the help of a 30 cm scale from base to 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 days interval.

2.6 Root length and root and shoot length ratio

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

Root shoot length ratio= (length of root)/ (length of shoot)

2.7 Fresh and dry weight

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

2.8 Dry matter accumulation

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

Dry matter accumulation (%) = (Dry weight)/ (Fresh weight) ×100

2.9 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 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 at par with coco peat and FYM (67.50), and coco peat and vermicompost (65). This was followed by soil + sand + vermicompost (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 was a 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 at par. Similarly, the interaction between variety and growth media had 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

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germination time (8.922 days), which was statistically at 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 at par with soil media (10.392). Similarly, there was a significant difference in mean germination time among different varieties. The variety Khumal-2 with a lower mean germination time (9.01) was statistically at 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). 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. Maximum speed of germination was recorded in media with coco peat (1.745), which was statistically at 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. Interaction between varieties and growth media had 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 probablity	$<0.001^{**}$	$<0.001^{**}$	$<0.001^{**}$
Varieties			
Srijana	59.7^{b}	9.55^{a}	1.372
Khumal-2	56.9^{b}	9.01^{a}	1.406
Khumal-3	55^{b}	9.55^{a}	1.271
Monoprecos	66.1^{a}	10.26^{b}	1.413
sem±	2.24	0.203	0.0534
$LSD_{(0.05)}$	6.37	0.576	
F probability	0.004^{**}	$<0.001^{**}$	ns
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 was a 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, 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 at par with coco peat + FYM (2.682) and coco peat only (2.576). The lowest seedling shoot length was found in media with sand + soil + FYM (1.195), which was statistically at 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 at 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 media, but the variety Khumal-2 showed the highest shoot length in the coco peat + FYM medium.

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

At 28 DAS, 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 at par with soil + sand + vermicompost (7.013) and soil + sand + FYM (6.619). Minimum seedling shoot length was found in soil media (6.02), which was statistically at par with only coco peat (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 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 at par with the root length of soil + sand + vermicompost media (6.845) and coco peat + FYM (6.774). Minimum root length was observed in soil media (5.875), which was statistically at par with soil + sand + FYM (5.986) and coco peat media (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 root length of seedlings.

There was a significant difference in 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 media (0.895), which was statistically at par with soil + sand + vermicompost (0.981), coco peat + FYM (0.957), and coco peat only (0.923), as shown in Table 3. Varieties across the growing media had non-significant results at the 5% and 1% levels of significance. 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 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 at par with coco peat media (964) and coco peat + FYM (942). This was followed by soil + sand + vermicompost (822), which was statistically at par with coco peat + FYM (942). The minimum seed vigor index was observed in soil media (524), which was statistically at par with sand + soil + FYM (618). Similarly, there was a significant difference in seed vigor index among varieties at the 5% and 1% levels of significance. When varieties were tested individually across the growing medium, the highest seed vigor index was found in Monoprecos (933.8), whereas the seed vigor index of the other three varieties was statistically at par (Table 3). 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), 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**
Variety			
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**	0.527ns	0.286ns
% 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 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 at 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 medium, the maximum seedling fresh weight was found in the Khumal-2 variety (1.156), which was statistically at par with Monoprecos (1.143) and Srijana (1.230). The minimum seedling fresh weight was recorded in Khumal-3 (0.978) (Table 4). 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). This was followed by coco peat + FYM (0.1418), which was statistically at 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 at 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 found in Srijana (0.1378), whereas the dry weight of the other three varieties was statistically at par (Table 4). Interaction between growing media and different varieties had non-significant results.

There were significant differences in dry matter accumulation percentage of seedlings among different growing media at the 5% and 1% levels of significance. The highest mean dry matter accumulation was found in coco peat + vermicompost (12.90). This was followed by soil + sand + vermicompost (11.79), which was statistically at par with coco peat + FYM (10.95), sand + soil + FYM (10.90), and soil (10.23). The lowest dry matter accumulation was recorded in the growing medium with coco peat (8.20) (Table 4). However, varieties across the growing media had non-significant results in terms of seedling dry matter accumulation. Interaction between growing media and different varieties 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**
Variety			
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**	0.804ns
Growing Media* Variety (F pr.)	0.002**	Ns	ns
% CV Grand Mean	17.3 1.127	16.7 0.1236	19.6 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 varies across the treatments. The higher germination percentage and the higher speed of germination on coco peat is due to having adequate porosity and water holding capacity [26]. According to Zaller, (2007); application of vermi-compost significantly affects the germination of seed which supports our findings. Germination percentage was positively affected by use of fertilizer, and use of suitable growing media, all source of nutrient had a significant impact on germination of seed [27]. Coco peat facilitates earlier~~facilitates to earlier~~ germination of seed by creating suitable conditions for earlier germination of seed as it provides proper aeration and moisture for seed germination [28] which supports our findings. Growth mediums with coco peat, vermicompost, FYM found significant impact due to combination of all essential factors, which improve physical, biological and nutritional quality of media [29].

Seedling shoot length, root length, root length to shoot length ratio, seed vigor index and biomass accumulation (fresh and dry weight) of tomato seedling which indicate the overall quality of the seedling varied significantly across the treatments. Compared to controlled treatment considerably all of these parameters were recorded higher in media containing vermicompost and coco peat. This is supported by the higher content of available nutrients~~nutrient~~ in vermicompost and higher porosity and water holding capacity of coco peat. Higher seedling shoot length resulting from application of vermicompost might be due to the presence of humic acid, which enhances the soil physical condition and facilitates utilization of plant nutrients in tomato [30]. The superiority of vermin-compost on growth and development of root might be due to its property of better physical structure, which contains~~contain~~ the balanced~~balance~~ composition of all essential nutrients [31]. Vermicompost helps in better root to shoot length ratio by providing nutrients for healthy seedling growth, by improving physical properties of growing medium Similarly, coco peat provides better aeration, high moisture holding capacity and better root penetration, and in presence of light source of fertilizer like vermicompost coco peat help in better development of root and shoot of seedling [32]. Seedling vigor index determines the overall health of seedling and yield of the crop higher seed vigor index on coco peat + vermicompost, which might be due to having good water holding capacity as well as sufficient porosity which permits adequate gaseous exchange between media and seed and support seedling growth [33]. The lower seed vigor index in soil may be due to poor drainage, development of root might be affected and high incidence of soil borne disease [34]. The higher seedling fresh and dry weight and dry matter accumulation (%)

in coco peat + vermicompost might be due to porosity, water holding capacity and nutrient exchange capacity of growing medium which promotes the vigorous growth of root and helps in better uptake of nutrients and ensures better biomass accumulation [35].
Difference in germination percentage, mean germination time seed vigor index, fresh and dry weight of seedling among varieties might be due to quality of seed and genetic factor of varieties.

5. Conclusions

In conclusion~~conclusions~~, the result of the current~~of current~~ experiment revealed that tomato seeds on coco peat were successful for higher germination percentage, lower mean germination time, and higher speed of germination. Different growth parameter like seedling shoot length, root length, fresh and dry weight of seedling, dry matter accumulation %, root length, root to shoot ratio and seedling vigor index were seen higher in Coco peat + Vermicompost and lowest in media with only coco peat which was statistically at par soil as control. Among varieties germination %, seed vigor index found highest in Monoprecos variety and mean germination time of Srijana, Khumal-2 and monoprecos were statistically at par. Mean seedling shoot length, root length and root to shoot length ratio did not vary across the varieties. Interaction between varieties and growing media shows significant impact on root length, fresh weight of seedling and DM accumulation. Above results demonstrate that germination and seedling growth of tomato might be differently affected by different growing media and less affected by varieties selected. Growing media treatment was not varieties specific to tomato in seedling production as all varieties give 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 which could be useful for farmers, future research, who are involved in 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.

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