

# Effect of Different Nutrient Media in Growth and Health of Tomato Seedlings in Arghakhanchi District (Nepal)

## ABSTRACT

This research was performed on March-May 2021 to evaluate the effects of different growth media on health and growth characteristics of tomato (*Solanum lycopersicum* L.) seedlings. The experiment was laid in Completely Randomized Design (CRD) with five treatments and four replications. The different nutrient media used were FYM, Poultry Manure, Vermicompost and Cocopeat each with 1:1 mix with soil. The other nutrient medium being soil only as a control treatment. Seeds of Manisha variety were sown on the tray under the high-tech greenhouse nursery with respective treatments. Data entry and arrangement of collected data was done using MS Excel and further analysis was done using R-studio. At 14 days after sowing, FYM (93.33%) and Cocopeat (94.17%) had the highest germination percentage while control (70%) had the lowest percentage of germinated seedlings. Other parameters as seedling height (10.78 cm), plant stand (90.83%) and leaf number (10.75) were found higher in cocopeat +soil (1:1) treatment. Disease incidence (33.4%), however, was found higher in poultry manure. From this experiment, Cocopeat +soil (1:1) mix proved to be the best medium for raising tomato seedlings as disease incidence was low, germination percentage was higher including final plant stand, seedling height and leaf number as compared to other nutrient media.

*Keywords: Tomato, Disease, Germination, Growth media, Vigor*

## 1. INTRODUCTION

Tomato (*Solanum lycopersicum* L.), botanical family: Solanaceae, is one of the important crops used as a fresh vegetable as well as in a variety of processed and ready-to-eat products [1]. Tomato is one of the most widely consumed vegetables in the world, with a production value of more than 90 billion USD annually [2]. Tomato is also known as the poor man's apple in Nepal [3]. In Nepal, the average annual tomato consumption is 11.97 kilograms per person [4]. Tomato is the third most important vegetable farmed in Nepal, according to the Food and Agriculture Organization of the United Nations (FAO). Tomato was grown in about 20,000 hectares in Nepal in the fiscal year 2013/14 [5], with an average productivity of 15 tons per hectare. This number climbed to 22,566 hectares in the year 2018/19 [6], with a productivity of 18 tons per hectare. Agro-ecological diversity in Nepal within short latitudinal distance provides comparative advantages for production of tomato in different seasons. There is great market potential for off season tomato produced along the mid-hill's ecology both within and outside the country [3].

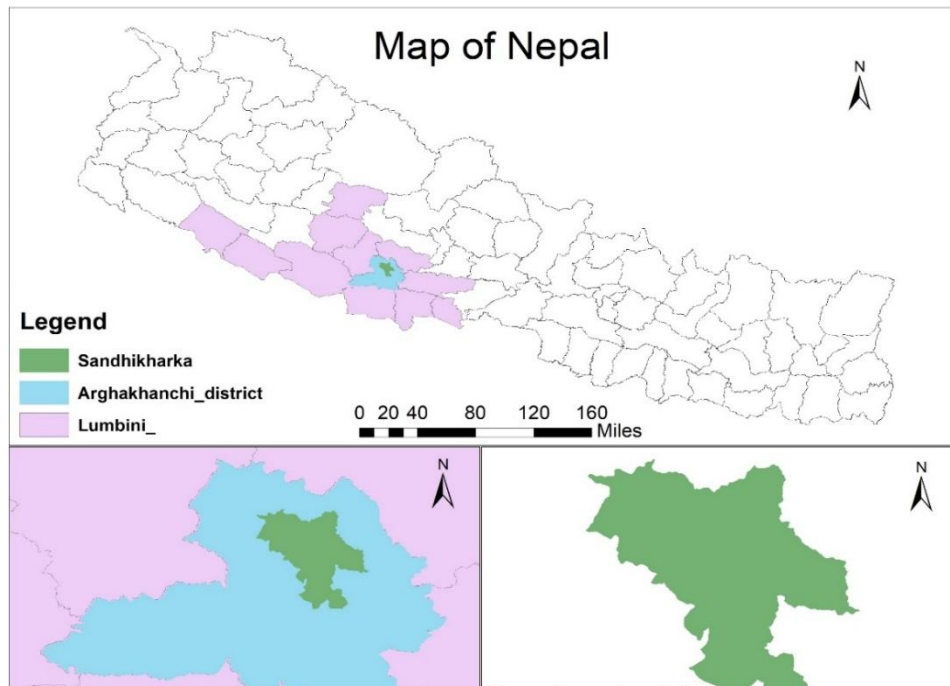
32 Tomato is grown throughout the year in recent times in Nepal after the introduction of plastic  
33 house for off season production [3]. Previously, tomato was used to be grown only during the  
34 summer monsoon season in the hills at subsistence level. But the introduction of improved  
35 varieties made it possible to produce tomato in the spring season as well [3]. Tomato  
36 cultivation inside plastic tunnels in summer-rainy season in the hills is getting popularity  
37 which is sold as off-season product fetching higher prices, which provides a comparative  
38 advantage for mid and high hills for income generation. It is economically attractive as it is a  
39 relatively short duration crop, gives a high yield and the area under cultivation is increasing  
40 every year [3]. For the successful production and high yield of tomato, the production of  
41 healthy and vigorous seedlings is required. Germination of the seedlings is a critical stage in  
42 plant life cycle as it determines the health and vigor of the plant directly [7]. Tomato nursery  
43 can be raised in different structures ranging from simple plastic shelters to controlled  
44 greenhouses. Whatever the structure used, it must protect seedlings from extreme  
45 environmental conditions like heavy rainfall, extremely fluctuating temperatures, high relative  
46 humidity and exposure to pests and diseases.  
47 Fertilizers play an important role in the health of seedlings [8]. The essential plant nutrients  
48 which include carbon, oxygen and hydrogen are absorbed from the air, whereas other  
49 nutrients including nitrogen are typically obtained from the soil and they contribute more than  
50 95% of a plant's biomass on a dry weight basis. The micronutrients are present in plant  
51 tissue in minute quantities but also play greater role in determining the health and vigor of  
52 the plant. Nitrogen or potassium are most commonly deficient in soils of low fertility and need  
53 to be added to nursery soils. Many studies have shown that there is linear relationship  
54 between relative growth rate and plant nitrogen concentration. Nitrogen is the most important  
55 nutrient for the plant as it is essential for the production of many cellular components [9].  
56 Tomatoes can grow well enough within a variable range of levels of every nutrient. However,  
57 manipulation of the nutrient provides opportunity for achieving the high yields of excellent  
58 quality fruit required for profitable production. Usually, animal manures are used to supply  
59 nitrogen for crops as traditional fertilizer. Nitrogen content in manure varies with the kind of  
60 animal and feed, storage, and handling strategies. Water content can also be considered  
61 another reason for variations in nutrient content. Fertilizers have marked effect on severity of  
62 plant diseases, either decreasing or increasing it. Different biotic and abiotic agents are  
63 responsible for the disease in tomato. Tomatoes are susceptible to many fungal diseases  
64 which cause infection through the roots.  
65 Tomato farming is considered as a high-risk activity due to high susceptibility to pests and  
66 diseases and high demand for inputs and services, which lead to high cost per unit area [10].  
67 Damping off is one of the most common diseases of tomato. It has many causative agents  
68 like *Fusarium*, *Pythium*, *Rhizoctonia* and *Verticillium*. It appears immediately after onset of  
69 monsoon when it is most conducive to its onset and spread. The fungus attack usually starts  
70 on germinating seeds, spreading to the hypocotyl, basal stem and developing tap root. The  
71 affected tissues rot and then the seedlings collapse. In a nursery plot the disease may start  
72 in small patches and eventually within two to four days the entire lot of seedlings may be  
73 destroyed [11]. Damping off is common occurrence in nursery beds and young seedlings  
74 resulting in reduced seed germination and poor stand. Other infections include root rot, late  
75 blight, early blight, fusarium wilt and powdery mildew.  
76 This study addresses the major problem regarding tomato farming and cultivation practices  
77 at local level. The major objectives of this research were to compare the disease incidence  
78 of tomato seedlings in different nutrient conditions and to find out the effect of nutrient source  
79 on general characters of tomato seedlings. This type of site and commodity specific research  
80 can help to understand and promote better crop management practices among local farmers  
81 which can ultimately be beneficial for increasing domestic production.

## 82 **2. MATERIAL AND METHODS**

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### 84 **2.1 Site description**

85 This study was carried out at Arghakhanchi district of Nepal in March-May 2021. The  
86 experimental field was located in the humid sub-tropical region of Nepal having elevation of  
87 960 masl. Arghakhanchi is one of the districts of Lumbini Province located in the mid hills  
88 between 28° N and 29° N latitude to 81° E and 83° E longitude. The district ranges from 305-  
89 2575 m in altitude. Due to variation in altitude, temperature differences can be seen. The  
90 average annual rainfall was approximately 1600 mm.  
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Fig. 1: Research site and study area

## 94 2.2 Research design

95 The experiment was conducted to compare the growth and health quality of tomato  
96 seedlings of Manisha variety raised in different nutrient media. The experiment was  
97 performed in completely randomized design (CRD) inside a greenhouse nursery and  
98 consisted of the following five treatments:

99

100 T<sub>1</sub>: Vermicompost + soil (1:1)

101 T<sub>2</sub>: FYM + soil (1:1)

102 T<sub>3</sub>: Poultry manure + soil (1:1)

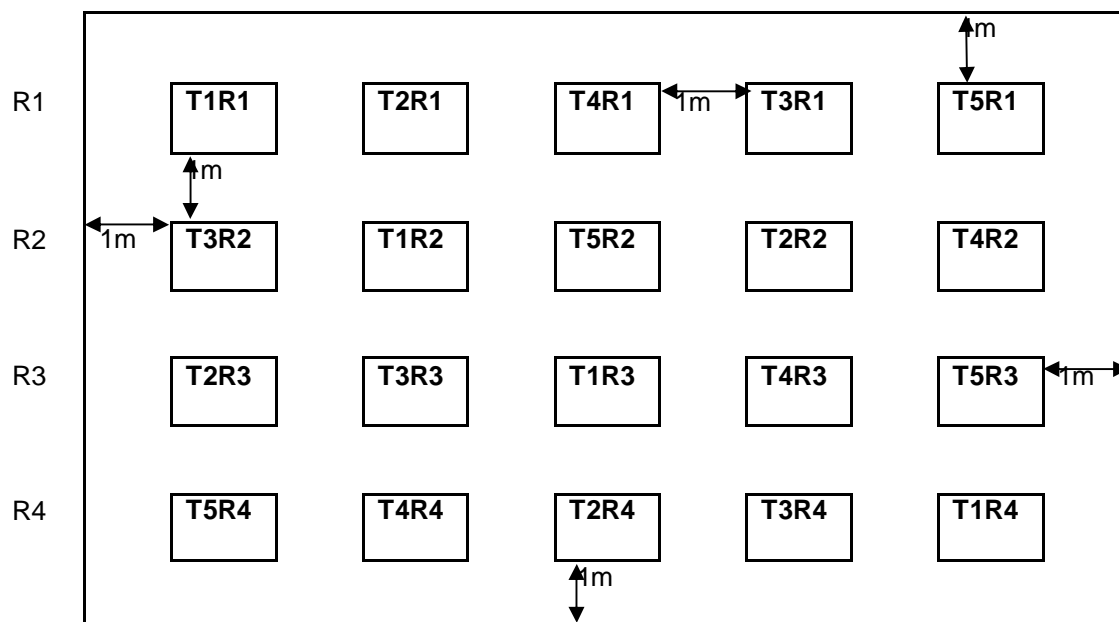
103 T<sub>4</sub>: Cocopeat + soil (1:1)

104 T<sub>5</sub>: Control (soil)

105 For all the treatments there were 4 replications (R1, R2, R3, R4) with 5 plots within each  
106 replication. Each plot consisted of a seedling tray and in each tray 30 seeds were sown. The  
107 layout of the plots in the field was as follows:

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109



R= replication, T= treatment

Fig. 2: Research layout

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### 2.3 Research inputs

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The seeds of selected variety for research were brought from a certified source. The required manures and other inputs were obtained from the local sources. Different fertilizers were mixed in 1:1 ratio by volume with soil and filled uniformly in the trays for seed sowing. After filling of the growing media or the mixture in the trays, one tomato seed per compartment were sown 1 cm deep and total 30 seeds were sown in each tray. After seed sowing, watering of the trays was done at regular intervals, starting from the day of sowing.

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### 2.4 Sample and sampling technique

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10 plants were chosen inclusive of various intra-plot variations. The sample plants were chosen among the plants which remained after the border plants were excluded. For the evaluation of effect of different nutrient media on tomato seedlings growth, health and physical quality, data was collected from the tagged plants at different times according to the requirement.

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### 2.5 Type of data

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Observations were taken for germination percentage, disease incidence, plant stand, plant height (including shoot length and root length) and leaf number.

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#### 2.5.1 Germination percentage

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The germinated seedlings were noted at 8, 10, 12 and 14 DAS. The germination percentage was determined by using the following formula:

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$Germination\ percentage = (Number\ of\ germinated\ seeds / total\ no.\ of\ seeds\ sown) \times 100$

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[12]

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#### 2.5.2 Disease incidence

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The number of diseased plants infected with damping off among the total germinated seedlings was assessed at 8, 12, 16 and 20 DAS.

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$Percentage\ disease\ incidence = (No.\ of\ diseased\ seedlings / no.\ of\ germinated\ seedlings) \times 100$

139

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141 [13]

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143 **2.5.3 Total plant stand**

144 Total plant population was noted after 20 days of sowing. The plants surviving until final  
145 reading were recorded as the plant stand.

146

147 **2.5.4 Plant height**

148 The height of the randomly selected plants from each tray was measured subsequently after  
149 20 DAS.

150 *Total plant height = Root length + Shoot length*

151

152 **2.5.5 Leaf number**

153 From the selected plants the leaf number was taken by counting the leaves in each plant.

154

155 **2.6 Analysis of data**

156 The entry of collected data was done in Microsoft Excel and R-Studio was used as the  
157 inferential and descriptive statistical tool. The ANOVA tables were obtained for the  
158 parameters to discuss and infer results with the support of some relevant literatures.

159

160 **3. RESULTS AND DISCUSSION**

161

162 The germination percentage was found to be statistically significant. The result showed that  
 163 varying the nutrient media affected the germination of tomato as shown in Table 1. Two  
 164 treatments (FYM + soil and Cocopeat + soil) were found superior with 93.33% and 94.17%  
 165 germination respectively. However, only 70% seeds germinated in control treatment. Seed  
 166 germination is favored by the growth medium as it promotes water absorption, nutrient  
 167 availability and oxygen supply to the germinating seeds and seedlings [14]. High percentage  
 168 of germination in cocopeat is due to good physical and chemical properties because of less  
 169 compactness and more porosity of the medium [15]. The use of fertilizers in soil positively  
 170 affected the seed germination process and the experiment showed that with the addition of  
 171 nutrient source, the percentage of germination enhanced as compared to control treatment.  
 172

173 Table 1. Effect of different nutrient media on germination percentage of tomato seedlings

Treatment	Germination percentage			
	8 DAS	10 DAS	12 DAS	14 DAS
FYM+ soil (1:1)	43.33 <sup>b</sup>	60.00 <sup>a</sup>	80.00 <sup>a</sup>	93.33 <sup>a</sup>
Poultry manure+ soil (1:1)	25.83 <sup>d</sup>	47.50 <sup>b</sup>	71.67 <sup>b</sup>	82.50 <sup>b</sup>
Vermicompost+ soil (1:1)	34.17 <sup>c</sup>	51.66 <sup>b</sup>	75.83 <sup>ab</sup>	85.00 <sup>b</sup>
Cocopeat+ soil (1:1)	49.17 <sup>a</sup>	65.00 <sup>a</sup>	79.17 <sup>a</sup>	94.17 <sup>a</sup>
Control (soil)	25.00 <sup>d</sup>	39.17 <sup>c</sup>	59.17 <sup>c</sup>	70.00 <sup>c</sup>
SEm (+/-)	1.68	2.08	1.56	1.52
F probability	***	***	***	***
LSD (=0.05)	5.06	6.28	4.72	4.58
CV %	9.47	7.92	4.28	3.58
Grand mean	35.50	52.67	73.17	85.00

174 *Note: Treatment means followed by common letter(s) within column are not significantly*  
 175 *different among each other based on DMRT at 5% level of significance. DAS= Days After*  
 176 *Sowing, LSD= Least Significant Difference, CV= Coefficient of Variation, \*\*\* denote*  
 177 *significant at 0.001P level.*

178

179 With increasing days after sowing, the disease incidence also increased. Results indicate  
 180 that disease incidence was significantly different in different treatments measured at different  
 181 days after sowing. Maximum disease incidence was found in seedlings growing in poultry  
 182 manure + soil (1:1) treatment. At 8 DAS, maximum percentage of seedlings were infested in  
 183 treatment containing poultry manure (51.39%) being at par with vermicompost (44.50%)  
 184 while lowest infestation was observed in FYM (21.06%) being at par with cocopeat (28.86%).  
 185 At 12 DAS, maximum disease incidence was found in poultry manure (30.32%) followed by  
 186 vermicompost (24.19%), cocopeat (20.08%), control (18.30%) and lowest being FYM

187 (15.59%). Similarly, at 16 DAS, maximum disease incidence was found in poultry manure  
 188 (30.32%) followed by vermicompost (23.50%), cocopeat (20.38%), control (17.82%) and  
 189 FYM (16.94%). Finally, at 20 DAS, maximum percentage of disease incidence was observed  
 190 in poultry manure (33.40%) followed by vermicompost (25.46%), cocopeat (20.38%), control  
 191 (20.26%) and control (19.63%). Higher disease incidence in treatment consisting of poultry  
 192 manure may be due to high nitrogen level combined with infected manure with disease  
 193 inoculum. Damping off increases with poor soil drainage, compaction, overly moist  
 194 conditions and use of infected manure [16]. [9] also suggested that high nitrogen decreased  
 195 the accumulation of defense related compounds in plants and hence increased the disease  
 196 incidence.

197  
 198

Table 2. Effect of different nutrient media on incidence of damping off in tomato seedlings

Treatment	Disease incidence			
	8 DAS	12 DAS	16 DAS	20 DAS
FYM+ soil (1:1)	21.06 <sup>c</sup>	15.59 <sup>c</sup>	16.94 <sup>c</sup>	19.63 <sup>c</sup>
Poultry manure+ soil (1:1)	51.39 <sup>a</sup>	30.32 <sup>a</sup>	30.32 <sup>a</sup>	33.40 <sup>a</sup>
Vermicompost+ soil (1:1)	44.50 <sup>a</sup>	24.19 <sup>b</sup>	23.50 <sup>b</sup>	25.46 <sup>b</sup>
Cocopeat+ soil (1:1)	28.86 <sup>bc</sup>	20.08 <sup>bc</sup>	20.38 <sup>bc</sup>	20.38 <sup>c</sup>
Control (soil)	33.03 <sup>b</sup>	18.30 <sup>c</sup>	17.82 <sup>c</sup>	20.26 <sup>c</sup>
SEm (+/-)	3.12	1.53	1.24	1.09
F probability	***	***	***	***
LSD (=0.05)	9.39	4.61	3.75	3.27
CV %	17.42	14.08	11.40	9.11
Grand mean	35.77	21.70	21.79	23.83

199 *Note: Treatment means followed by common letter(s) within column are not significantly*  
 200 *different among each other based on DMRT at 5% level of significance. DAS= Days After*  
 201 *Sowing, LSD= Least Significant Difference, CV= Coefficient of Variation, \*\*\* denote*  
 202 *significant at 0.001P level.*

203

204 Average plant height of tomato seedlings (as calculated by adding shoot length and root  
 205 length) measured at 20 DAS was found significantly different in different treatments. It was  
 206 highest in treatment containing cocopeat (10.78 cm) followed by vermicompost (10.38 cm).  
 207 Similarly, average plant height in other treatments, FYM (9.79 cm), poultry manure (8.95 cm)  
 208 and lowest in control (7.98 cm).

209 Average shoot length at 20 DAS was found highest in treatment containing FYM (6.00 cm)  
 210 being at par with cocopeat (5.91 cm) followed by poultry manure (5.44 cm), control (5.38 cm)  
 211 and vermicompost (5.34 cm). Meanwhile, the average root length measured at 20 DAS was  
 212 found highest in treatment containing cocopeat (4.32 cm) followed by FYM (3.84 cm),  
 213 vermicompost (3.79 cm), poultry manure (3.55 cm) and lowest in control (3.37 cm).

214 Similarly, the shoot: root ratio was lowest in cocopeat (1.37) and highest in control (1.60)  
 215 which indicated that seedlings had best shoot and root growth in cocopeat and less vigorous  
 216 growth in control treatment.  
 217 Cocopeat improves root length due to better moisture content, air content and drainage [17].  
 218 Cocopeat and vermicompost enhances higher potassium uptake which improves growth  
 219 [18]. Cocopeat and vermicompost sustain more root and shoot growth due to better aeration  
 220 properties [19].

221  
 222

Table 3. Effect of different nutrient media on height of tomato seedlings (20 DAS)

Treatment	Shoot length (cm)	Root length (cm)	Plant height (cm)	Shoot: Root ratio
FYM+ soil (1:1)	6.00 <sup>a</sup>	3.84 <sup>b</sup>	9.79 <sup>c</sup>	1.56 <sup>a</sup>
Poultry manure+ soil (1:1)	5.44 <sup>b</sup>	3.55 <sup>c</sup>	8.95 <sup>d</sup>	1.53 <sup>a</sup>
Vermicompost+ soil (1:1)	5.34 <sup>b</sup>	3.79 <sup>b</sup>	10.38 <sup>b</sup>	1.41 <sup>b</sup>
Cocopeat+ soil (1:1)	5.91 <sup>a</sup>	4.32 <sup>a</sup>	10.78 <sup>a</sup>	1.37 <sup>b</sup>
Control (soil)	5.38 <sup>b</sup>	3.37 <sup>d</sup>	7.98 <sup>e</sup>	1.60 <sup>a</sup>
SEm (+/-)	0.08	0.037	0.06	0.03
F probability	***	***	***	***
LSD (=0.05)	0.23	0.11	0.17	0.08
CV %	2.70	1.95	1.16	3.60
Grand mean	5.61	3.77	9.58	1.49

223 *Note: Treatment means followed by common letter(s) within column are not significantly*  
 224 *different among each other based on DMRT at 5% level of significance. DAS= Days After*  
 225 *Sowing, LSD= Least Significant Difference, CV= Coefficient of Variation, \*\*\* denote*  
 226 *significant at 0.001P level.*

227

228 Plant stand in different treatments was found significantly different when measured at 20  
 229 DAS. Maximum plant stand was observed in treatment with cocopeat (90.83%) being at par  
 230 with FYM (88.33%) followed by vermicompost (81.67%) and poultry manure (77.5%). The  
 231 lowest plant stand was observed in control (68.33%). Cocopeat and FYM showed better  
 232 plant stand than other treatments.

233 Increase in the growth, survival and final plant stand might be due to better moisture  
 234 availability, optimum pH, lesser disease incidence in cocopeat medium. Cocopeat and  
 235 vermicompost enhance potassium uptake [18] and higher potassium content, low bulk  
 236 density, high aeration and water holding capacity all contribute to the improved growth and  
 237 plant stand of tomato [20].

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242

243 Table 4. Effect of different nutrient media on final plant stand of tomato seedlings (20 DAS)

Treatment	Plant stand (20 DAS)
FYM	88.33 <sup>a</sup>
Poultry manure	77.50 <sup>b</sup>
Vermicompost	81.67 <sup>b</sup>
Cocopeat	90.83 <sup>a</sup>
Control	68.33 <sup>c</sup>
<hr/>	
SEm (+/-)	1.52
F probability	***
LSD (=0.05)	4.58
CV %	3.74
<hr/>	
Grand mean	81.33

244 *Note: Treatment means followed by common letter(s) within column are not significantly*  
 245 *different among each other based on DMRT at 5% level of significance. DAS= Days After*  
 246 *Sowing, LSD= Least Significant Difference, CV= Coefficient of Variation, \*\*\* denote*  
 247 *significant at 0.001P level.*

248  
 249 Average leaf number measured in matured seedlings at 20 DAS was found significantly  
 250 different in different treatments. Maximum leaf number was observed in treatment containing  
 251 cocopeat (10.75) followed by vermicompost (10.18). Leaf number was found similar in  
 252 treatments containing FYM (9.15) and poultry manure (9.15). Lowest number of leaves was  
 253 observed in control treatment (8.68). Addition of cocopeat and vermicompost in the growing  
 254 media favored better growth and higher leaf number in comparison to all the other media  
 255 compositions [21].

256  
 257 Table 5. Effect of different nutrient media on average leaf number of tomato seedlings (20  
 258 DAS)

Treatment	Leaf number
FYM+ soil (1:1)	9.15 <sup>c</sup>
Poultry manure+ soil (1:1)	9.15 <sup>c</sup>
Vermicompost+ soil (1:1)	10.18 <sup>b</sup>
Cocopeat+ soil (1:1)	10.75 <sup>a</sup>
Control (soil)	8.68 <sup>d</sup>

SEm (+/-)	0.06
F probability	***
LSD (=0.05)	0.17
CV %	1.22
Grand mean	9.58

259 *Note: Treatment means followed by common letter(s) within column are not significantly*  
260 *different among each other based on DMRT at 5% level of significance. DAS= Days After*  
261 *Sowing, LSD= Least Significant Difference, CV= Coefficient of Variation, \*\*\* denote*  
262 *significant at 0.001P level.*  
263

264 The above results indicated that there was significant difference in germination percentage  
265 of Manisha variety of tomato in different treatments applied. Cocopeat and FYM showed  
266 higher germination percentage. Maximum disease incidence was observed in poultry  
267 manure while seedling height, leaf number and plant stand were observed higher in  
268 treatment consisting of cocopeat + soil (1:1). All the results above point out that, on average,  
269 cocopeat + soil (1:1) medium performed better than every other treatment used in the  
270 experiment.  
271

#### 272 **4. CONCLUSION**

273  
274 The application of FYM, cocopeat, vermicompost and poultry manure had significant effects  
275 on germination percentage, incidence of damping off, plant height, leaf number and total  
276 plant stand in Manisha variety of tomato seedlings at Arghakhanchi. From this experiment,  
277 cocopeat +soil (1:1) treatment showed the best results for raising tomato seedlings inside  
278 the greenhouse at Arghakhanchi. The results obtained revealed that the use of cocopeat +  
279 soil (1:1) as a growing media, reduced the incidence of damping off and increased  
280 germination percentage, plant height and leaf number of tomato seedlings. This will enhance  
281 the final productivity of tomato by the production of healthy and vigorous seedlings which  
282 provide better yields. Based on the findings of this study, farmers can be advised to use  
283 cocopeat and soil mix medium for production of premium quality tomato seedlings.  
284 Furthermore, cocopeat is best suited for raising tomato seedlings considering the ease of  
285 applicability, availability, less risk of infection and easy to transplant.  
286

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293 research.  
294

295 **COMPETING INTERESTS**

296

297 “Authors have declared that no competing interests exist.”

298

299 **AUTHORS’ CONTRIBUTIONS**

300

301 ‘Samrat Panthi<sup>1</sup>’ designed the study, managed the literature searches, performed the  
302 statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. ‘Prativa  
303 Neupane<sup>1</sup>’ and ‘Anita Bhusal<sup>1</sup>’ managed the analyses of the study. All authors collaborated  
304 for the field experiment; read and approved the final manuscript.”

305

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