Original Research Article

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 also known as the poor man's apple in Nepal [2]. In Nepal, the average annual tomato consumption is 11.97 kilograms per person [3]. Tomato is the third most important vegetable farmed in Nepal, according to the Food and Agriculture Organization of the United Nations (FAO). 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 [2].

Tomato is grown throughout the year in recent times in Nepal after the introduction of plastic house for off season production [2]. Previously, tomato was used to be grown only during the summer monsoon season in the hills at subsistence level. But the introduction of improved varieties made it possible to produce tomato in the spring season as well [2]. Tomato cultivation inside plastic tunnels in summer-rainy season in the hills is getting popularity which is sold as off-season product fetching higher prices, which provides a comparative advantage for mid and high hills for income generation. It is economically attractive as it is a

relatively short duration crop, gives a high yield and the area under cultivation is increasing every year [2]. For the successful production and high yield of tomato, the production of healthy and vigorous seedlings is required. Germination of the seedlings is a critical stage in plant life cycle as it determines the health and vigor of the plant directly [4]. Tomato nursery can be raised in different structures ranging from simple plastic shelters to controlled greenhouses. Whatever the structure used, it must protect seedlings from extreme environmental conditions like heavy rainfall, extremely fluctuating temperatures, high relative humidity and exposure to pests and diseases.

Fertilizers play an important role in the health of seedlings [5]. The essential plant nutrients which include carbon, oxygen and hydrogen are absorbed from the air, whereas other nutrients including nitrogen are typically obtained from the soil and they contribute more than 95% of a plant's biomass on a dry weight basis. The micronutrients are present in plant tissue in minute quantities but also play greater role in determining the health and vigor of the plant. Nitrogen or potassium are most commonly deficient in soils of low fertility and need to be added to nursery soils. Many studies have shown that there is linear relationship between relative growth rate and plant nitrogen concentration. Nitrogen is the most important nutrient for the plant as it is essential for the production of many cellular components [6]. Tomatoes can grow well enough within a variable range of levels of every nutrient. However, manipulation of the nutrient provides opportunity for achieving the high yields of excellent quality fruit required for profitable production. Usually, animal manures are used to supply nitrogen for crops as traditional fertilizer. Nitrogen content in manure varies with the kind of animal and feed, storage, and handling strategies. Water content can also be considered another reason for variations in nutrient content. Fertilizers have marked effect on severity of plant diseases, either decreasing or increasing it. Different biotic and abiotic agents are responsible for the disease in tomato. Tomatoes are susceptible to many fungal diseases which cause infection through the roots.

Tomato farming is considered as a high-risk activity due to high susceptibility to pests and diseases and high demand for inputs and services, which lead to high cost per unit area [7]. Damping off is one of the most common diseases of tomato. It has many causative agents like *Fusarium, Pythium, Rhizoctonia* and *Verticillium*. It appears immediately after onset of monsoon when it is most conducive to its onset and spread. The fungus attack usually starts on germinating seeds, spreading to the hypocotyl, basal stem and developing tap root. The affected tissues rot and then the seedlings collapse. In a nursery plot the disease may start in small patches and eventually within two to four days the entire lot of seedlings may be destroyed [8]. Damping off is common occurrence in nursery beds and young seedlings resulting in reduced seed germination and poor stand. Other infections include root rot, late blight, early blight, fusarium wilt and powdery mildew.

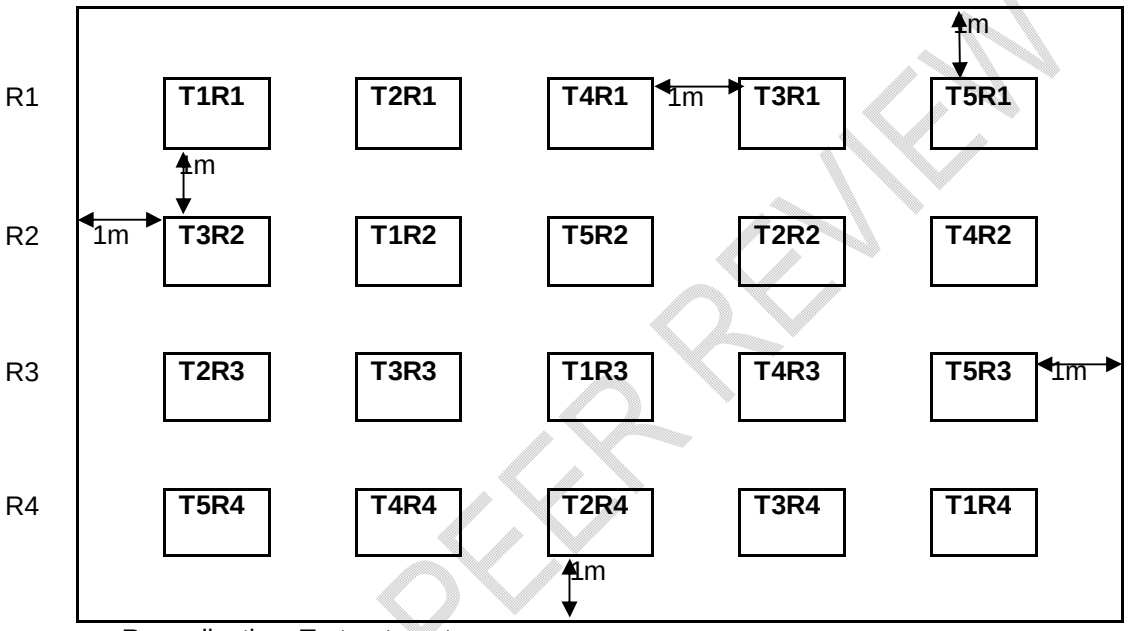
This study addresses the major problem regarding tomato farming and cultivation practices at local level. The major objectives of this research were to compare the disease incidence of tomato seedlings in different nutrient conditions and to find out the effect of nutrient source on general characters of tomato seedlings. This type of site and commodity specific research can help to understand and promote better crop management practices among local farmers which can ultimately be beneficial for increasing domestic production.

2. MATERIAL AND METHODS

The experimental field was located in the humid sub-tropical region of Nepal having elevation of 960 masl. Arghakhanchi is one of the districts of Lumbini Province located in the mid hills between 28° N and 29° N latitude to 81° E and 83° E longitude. The district ranges from 305-2575 m in altitude. Due to variation in altitude, temperature differences can be seen. The average annual rainfall was approximately 1600 mm.

The experiment was conducted to compare the growth and health quality of tomato seedlings of Manisha variety raised in different nutrient media. The experiment was

performed in completely randomized design (CRD) and consisted of the following treatments: T1: Vermicompost + soil (1:1), T2: FYM + soil (1:1), T3: Poultry manure + soil (1:1), T4: Cocopeat + soil (1:1) and T5: Control (soil). For all the treatments there were 4 replications (R1, R2, R3, R4) with 5 plots within each replication. 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 in the trays for seed sowing. In each plot (tray) 30 seeds were sown. The required parameters were observed from the 10 sample plants selected at required interval. Observations were taken for germination percentage, disease incidence, plant stand, plant height and leaf number.



R= replication, T= treatment

Fig. 1: Research layout

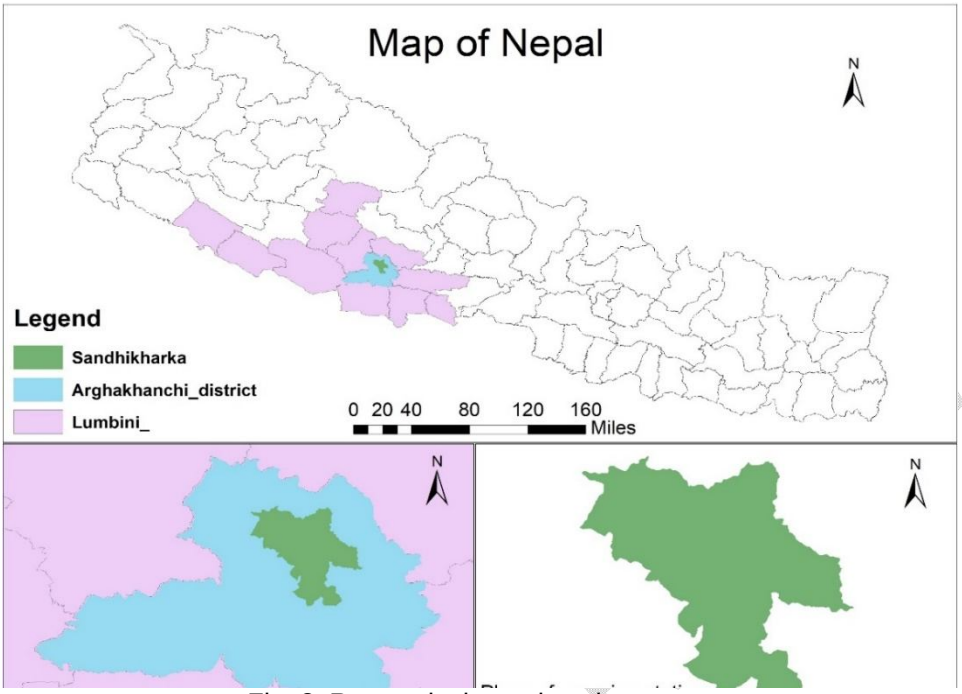


Fig. 2: Research site and study area

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.

2.1 Germination percentage

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

Germination percentage = (Number of germinated seeds / total no. of seeds sown) × 100

[9]

2.2 Disease incidence

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

Percentage disease incidence = (No. of diseased seedlings/ no. of germinated seedlings) × 100

[10]

2.3 Total plant stand

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

2.4 Plant height

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

Total plant height = Root length + Shoot length

2.5 Leaf number

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

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

3. RESULTS AND DISCUSSION

The germination percentage was found to be statistically significant. The result showed that varying the nutrient media affected the germination of tomato as shown in Table 1. Two treatments (FYM + soil and Cocopeat + soil) were found superior with 93.33% and 94.17% germination respectively. However, only 70% seeds germinated in control treatment. Seed germination is favored by the growth medium as it promotes water absorption, nutrient availability and oxygen supply to the germinating seeds and seedlings [11]. High percentage of germination in cocopeat is due to good physical and chemical properties because of less compactness and more porosity of the medium [12]. The use of fertilizers in soil positively affected the seed germination process and the experiment showed that with the addition of nutrient source, the percentage of germination enhanced as compared to control treatment.

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^{b}	60.00^{a}	80.00^{a}	93.33^{a}
Poultry manure+ soil (1:1)	25.83^{d}	47.50^{b}	71.67^{b}	82.50^{b}
Vermicompost+ soil (1:1)	34.17^{c}	51.66^{b}	75.83^{ab}	85.00^{b}
Cocopeat+ soil (1:1)	49.17^{a}	65.00^{a}	79.17^{a}	94.17^{a}
Control (soil)	25.00^{d}	39.17^{c}	59.17^{c}	70.00^{c}
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

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

With increasing days after sowing, the disease incidence also increased. Results indicate that disease incidence was significantly different in different treatments measured at different days after sowing. Maximum disease incidence was found in seedlings growing in poultry manure + soil (1:1) treatment. At 8 DAS, maximum percentage of seedlings were infested in

treatment containing poultry manure (51.39%) being at par with vermicompost (44.50%) while lowest infestation was observed in FYM (21.06%) being at par with cocopeat (28.86%). At 12 DAS, maximum disease incidence was found in poultry manure (30.32%) followed by vermicompost (24.19%), cocopeat (20.08%), control (18.30%) and lowest being FYM (15.59%). Similarly, at 16 DAS, maximum disease incidence was found in poultry manure (30.32%) followed by vermicompost (23.50%), cocopeat (20.38%), control (17.82%) and FYM (16.94%). Finally, at 20 DAS, maximum percentage of disease incidence was observed in poultry manure (33.40%) followed by vermicompost (25.46%), cocopeat (20.38%), control (20.26%) and control (19.63%). Higher disease incidence in treatment consisting of poultry manure may be due to high nitrogen level combined with infected manure with disease inoculum. Damping off increases with poor soil drainage, compaction, overly moist conditions and use of infected manure [13]. [6] also suggested that high nitrogen decreased the accumulation of defense related compounds in plants and hence increased the disease incidence.

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^{c}	15.59^{c}	16.94^{c}	19.63^{c}
Poultry manure+ soil (1:1)	51.39^{a}	30.32^{a}	30.32^{a}	33.40^{a}
Vermicompost+ soil (1:1)	44.50^{a}	24.19^{b}	23.50^{b}	25.46^{b}
Cocopeat+ soil (1:1)	28.86^{bc}	20.08^{bc}	20.38^{bc}	20.38^{c}
Control (soil)	33.03^{b}	18.30^{c}	17.82^{c}	20.26^{c}
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

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

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

Average shoot length at 20 DAS was found highest in treatment containing FYM (6.00 cm) being at par with cocopeat (5.91 cm) followed by poultry manure (5.44 cm), control (5.38 cm)

and vermicompost (5.34 cm). Meanwhile, the average root length measured at 20 DAS was found highest in treatment containing cocopeat (4.32 cm) followed by FYM (3.84 cm), vermicompost (3.79 cm), poultry manure (3.55 cm) and lowest in control (3.37 cm).
Similarly, the shoot: root ratio was lowest in cocopeat (1.37) and highest in control (1.60) which indicated that seedlings had best shoot and root growth in cocopeat and less vigorous growth in control treatment.
Cocopeat improves root length due to better moisture content, air content and drainage [14]. Cocopeat and vermicompost enhances higher potassium uptake which improves growth [15].

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[a]	3.84[b]	9.79[c]	1.56[a]
Poultry manure+ soil (1:1)	5.44[b]	3.55[c]	8.95[d]	1.53[a]
Vermicompost+ soil (1:1)	5.34[b]	3.79[b]	10.38[b]	1.41[b]
Cocopeat+ soil (1:1)	5.91[a]	4.32[a]	10.78[a]	1.37[b]
Control (soil)	5.38[b]	3.37[d]	7.98[e]	1.60[a]
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

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

Plant stand in different treatments was found significantly different when measured at 20 DAS. Maximum plant stand was observed in treatment with cocopeat (90.83%) being at par with FYM (88.33%) followed by vermicompost (81.67%) and poultry manure (77.5%). The lowest plant stand was observed in control (68.33%). Cocopeat and FYM showed better plant stand than other treatments.
Increase in the growth, survival and final plant stand might be due to better moisture availability, optimum pH, lesser disease incidence in cocopeat medium and higher phosphorous content. According to [16], phosphorous is involved in the formation of energy rich compounds, which in return derive various bio-chemical reactions within the plant including adenosine triphosphate and adenosine diphosphate.

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

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

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

Average leaf number measured in matured seedlings at 20 DAS was found significantly different in different treatments. Maximum leaf number was observed in treatment containing cocopeat (10.75) followed by vermicompost (10.18). Leaf number was found similar in treatments containing FYM (9.15) and poultry manure (9.15). Lowest number of leaves was observed in control treatment (8.68). Addition of cocopeat and vermicompost in the growing media favored better growth and higher leaf number in comparison to all the other media compositions [17].

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

Treatment	Leaf number
FYM+ soil (1:1)	9.15[c]
Poultry manure+ soil (1:1)	9.15[c]
Vermicompost+ soil (1:1)	10.18[b]
Cocopeat+ soil (1:1)	10.75[a]

Control (soil)	8.68[d]
SEm (+/-)	0.06
F probability	***
LSD (=0.05)	0.17
CV %	1.22
Grand mean	9.58

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

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

4. CONCLUSION

Thus, from this experiment, cocopeat +soil (1:1) treatment showed the best results for raising tomato seedlings inside the greenhouse at Arghakhanchi. So, it should be used for growing tomato seedlings as it reduced the disease incidence and increased germination percentage, plant height and leaf number. This will enhance the final productivity of tomato by the production of healthy and vigorous seedlings which provide better yields. Further, cocopeat can be readily available and there is a quick and easy process for preparing the medium. Also, it is best suited for raising tomato seedlings in trays with less risk of infection and higher chance of germination.
In conclusion, farmers are advised to use cocopeat and soil mix medium for production of premium quality tomato seedlings which provide better yields.

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