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EVALUATION OF DIFFERENT GROWING MEDIA FOR TOMATO AND SWEET PEPPER SEEDLINGS RAISING IN POKHARA, NEPAL

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ABSTRACT

Nine different compositions of growing media were evaluated for growing tomato and capsicum in two consecutive years (2020 and 2021). Experiments were conducted in Randomized Complete Block Design (RCBD) under rain shelter (poly house) with three replications. The growing media were Cocopeat, FYM+Cocopit+Perlite, FYM+Cocopit+Vermiculite, FYM+Perlite, FYM+Soil, FYM+Vermiculite, Vermicompost+Perlite, Vermicompost +Soil and Vermicompost+Vermiculite. There were significant (P<0.05) differences in the observed parameters like number of seedlings emergence, number of seedling establishment, number of leaves, seedling height and diameter of seedling stem among the tested growing media. The highest seedling emergence of tomato and sweet pepper were recorded in cocopeat as a growing media. After 30 days after seed sowing (DAS) in tomato, the highest number of seedling (103.5) were found in Cocopeat and the tallest seedling height (19.92 cm) was found in Vermicompost+perlite. Similarly, in Capsicum (40DAS), the highest number of seedling (83.5) were found for the growing media Cocopeat only, followed by Vermicompost + Perlite (78) and the tallest seedling height (13.89 cm) was found in Vermicompost+Vermiculite grown seedlings. The good root plug formation was found for the use of cocopeat. Therefore, use of vermicompost or FYM in the mixed form with cocopeat or the soil as a growing media would be sustainable technology for commercial seedling production of vegetables.

1. INTRODUCTION

Tomato (*Lycopersicon esculentum* L.) is a member of Solanaceae family, one of the most popular and widely grown vegetable crops in the world (Sharma & Singh, 2015). Tomato fruits can be consumed fresh or processed (Eivazi *et al*., 2013) and rich source of minerals and vitamins (Wilcox *et al*., 2003; Eivazi *et al*., 2013). Similarly, Sweet pepper (*Capsicum annuum* L.) belongs to the family Solanaceae and it is rich in vitamin C (Arancon *et al.,* 2010; El-Sayed *et al.,* 2015). Capsicum is consumed for their colour, taste and nutritional value (Perez-Lopez *et al.,* 2007).The cultivation of Solanaceous crops like Tomato and sweet pepper starts with the transplanting of seedlings in the main growing field. Healthy and robust seedlings production is utmost necessary because of great effect of the seedlings on the final crop establishment and yield. The expensive seeds (particularly of hybrids) of high value crops like tomato, brinjal, capsicum and cucumber etc. are being transplanted after growing in nursery under close observation and care to achieve maximum germination and healthy seedling production. Climatic conditions and seed sowing media have significant impact on seedling development (Hazarika *et al*., 2022). Seedling production in nursery bed can produce stress in plants during transplanting (Demir *et al*., 2010). Use of different growth media mainly helps to proper growth in nursery as well as easy adaptation in the field (Sterrett, 2001).

Growing media are substrates, other than soils for plants grown. These are organic materials like peat, compost, tree bark, coconut (*Cocos nucifera* L.) coir, poultry feathers and inorganic materials such as clay, perlite, vermiculite, and mineral wool (Grunert *et al*., 2008) or mixes such as peat and perlite; coir and clay, peat and compost (Nair *et al*., 2011).Growing media has direct impacts on seed germination, seedling emergence, seedling growth and quality of seedlings in a nursery stage (Unal, 2013). Growing media is source for seeds sowing and source of

plant nutrients (Indriyani *et al*., 2011). Besides this it also supports the root system to stand the plant (Abad *et al*., 2005).

Seedlings raised soil beds are prone to root damage during uprooting. Most of the commercial farmers are using seedling growing plug trays on vegetable seed germination and transplant establishment in various growing media (Nair *et al*., 2011). So adoption of plug-tray nursery raising technology is increasing. This technique helps vigorous root development as well as prevents the damage during transplanting. The use of this technology can grow large number of seedlings and it has high significance when the seedlings should be raised in semi/controlled conditions. For the commercial seedling production by use of plug tray there is use of cocopeat or vermicompost for the growing media. The use of only cocopeat for growing media require additional nutrient supplement during seedling growth and use of vermicompost will be higher cost for the farmers. For the production of seedlings under protected structure by using different growing media on plug tray should be evaluated. Some nurseries are using the mineral rocks for the seedling/sapling production of ornamental plants and some progressive farmers of Nepal also using cocopeat and vermicompost or cocopeat and FYM in 1:1 ratio by volume. Selection of cheaper and easily available organic materials for production of seedling is the way of sustainable seedling production as use of media. So the validation and verification of alternative growing media for plug tray in mixture of different concentration is necessary. For the healthy and economically viable seedling production, evaluation of different growing media with their mixture is necessary to verify the technology for commercial purpose. Very few researches or studies were carried out in Nepal to evaluate the quality parameters of the seedling by using growing media for seedling production of sweet pepper and tomato. Therefore, the aim of this study was to evaluate different growing media for the germination, growth and development of seedlings in plug tray under rain shelter plastic house.

2. MATERIALS AND METHODS

2.1 Experimental Site

The trial was conducted at Horticulture Research Station (HRS), Malepatan, Pokhara, Kaski district during the two consecutive seasons, of March, 2020 and April, 2021 under rain shelter. The station is located at about 28°13'6.8" N latitude and 83°58'27.72" E longitude with an elevation of 848 masl. The station has sub-tropical humid type of climate.

Table 1. Meteorological data of HRS,Malepatan for open field in 2020 and 2021

Year / Month	Temperature (^{0}C)			Rainfall (mm)	Relative Humidity (%)
	Maximum	Minimum	Average		
2020					
March	25.1	11.1	18.1	108.1	65.5
April	27.5	14.2	20.85	238.6	64.5
May	28.5	17.2	22.85	488.2	73.3
June	29.7	21.3	25.5	936.8	83.3
2021					
March	27.19	15.62	21.4	58.1	77.77
April	32.01	17.54	24.77	71.9	56.15
May	29.96	21.02	25.49	283.4	73
June	29.15	22.56	25.85	965.21	87.76

Source: Department of hydrology and meteorology, meteorological forecasting division, Pokhara, Kaski, Nepal

2.2 Growing Media

2.2.1 Soil

Soil is the universal media for the seedling growth and widely used for the most of the vegetable crops to raise their seedlings. We used top soil of this farm for the preparation of growing media. Soil is mixed with either FYM or vermicompost which increase its nutrient content and improve the soil condition for germination and seedling establishment.

2.2.2 Vermiculite

Vermiculite used in this study is micaceous mineral insoluble in water which absorbs large quantities of water and helps in aeration. It is normally mixed with other growth media because it contains magnesium and potassium minerals.

2.2.3 Perlite

It is gray colored, light sterile volcanic material containing no nutrients. Despite holding water, it is used for the improving of drainage and percent of aeration.

2.2.4 Cocopeat

It is by product of coconut processing for the fiber production. It has very low of nutrient content. It has excellent aeration due to its fine structure and it holds more moisture than other media.

2.2.5 Farmyard manure (FYM)

It is the organic manure comes from the excreta of livestock raised in farm.

2.2.6 Vermicompost

Vermicompost is the organic manure comes from the digestion of organic matter by earthworms and aerobic decomposition.

2.3 Growing pot

Plastic seedling trays (also known as plug trays or pro-trays) having 105 cavities (plugs) were used for the experiment and the type of cavities were inverted pyramid shaped and having the size of cup was 3x3x4 cm^3.

2.4 Experimental design

Nine different compositions of growing media were used for the Tomato and Capsicum seedling production.To compare the efficiency of different growing media for the seedling production; we made nine different growing media on volume basis and filled in pro-trays. Individual tray having one type of growing media is called experimental unit and they were put under RCBD design having three replications of each treatment. Trays were placed down under rain shelter for the seedling growth and application of water was performed by the help of watering can.

Table 2. Growing media treatment details used for the experiment

S.N.	Symbol	Composition on volume basis	Treatment
T1	Cocopeat	100%	Cocopeat
T2	F+C+P	1:1:1	FYM+Cocopeat +Perlite
T3	F+C+V	1:1:1	FYM+Cocopeat +Vermiculite
T4	F+P	1:1	FYM+Perlite
T5	F+S	1:1	FYM+Soil(Control)
T6	F+V	1:1	FYM+Vermiculite
T7	Vermicompost+P	1:1	Vermicompost+Perlite
T8	Vermicompost+S	1:1	Vermicompost+Soil
T9	Vermicompost+V	1:1	Vermicompost+Vermiculite

2.5 Plant materials

The used plant materials were Srijana hybrid variety of Tomato and California Wonder variety (OP) of Capsicum. The Srijana seed was own production of this farm and its germination test report was 100% while Sweet pepper seed was purchased from the seed market of Pokhara so the germination test of sweet pepper in lab was not performed.

2.6 Data collection

In the first year, the date of seed sowing was on March 2, 2020 and in the second year, the date of seed sowing was on April 29, 2021. The number of seed sowing per tray was 105. From each plastic tray which represents experiment units of growing media, we used five sample plants from the each tray for the evaluation of plant parameters. In tomato; the emergence data were recorded in the tenth day of sowing while in case of sweet pepper the data recording on emergence were done at 15 days after sowing (DAS). The data on growth parameters were observed at 30 DAS for tomato and 40 DAS for Capsicum. During this experiment no extra fertilizer were applied after seed germination for the growth and development so the growth of seedlings became little bit slower for transplanting in terms of height.

The data on plant height, stem diameter, number of leaves and length of root were measured from each treatment. The plant height was measured from the plant stem crown to the growing point of the plant. A measuring scale was used to measure the height. The stem diameter was measured by Vernier caliper at the base of seedling just 2 cm above the soil surface. The number of leaves were counted from the sample plant and the finally the length of root was measured by scale.

2.7 Data Analysis

The observed parameters were recorded and maintained on spread sheet. Analysis of variance was performed using R (version 3.6.3) and R Studio1.3.1093. Means were compared by Duncan's Multiple Range Test (DMRT) at 5% level of significance.

3. RESULTS AND DISCUSSION

3.1. Phenotypic condition of seedling during uprooting

Seedlings vigor and root plug formation were recorded by visual observation from sample seedlings. The growth vigor and root plug formation were presented in Table 3.

Table 3. The phenotypic growth of seedlings and the root plug condition of Tomato (30 DAS) and Capsicum (40 DAS) at HRS, Malepatan, Kaski in 2020 and 2021.

Treatment	Seedling vigor	Root plug formation
Cocopeat	Stunted growth and yellowing of seedlings	Good plug
FYM+Cocopeat +Perlite	Slightly yellow was started in seedling	Good plug
FYM+Cocopeat +Vermiculite	Healthy growth	Poor plug
FYM+Perlite	Healthy growth	Good plug
FYM+ Soil	Healthy growth	Good plug
FYM+Vermiculite	Healthy growth	Plug formation was very poor
Vermicompost+Perlite	Healthy growth	Plugging poor but quite better than use of vermiculite
Vermicompost+Soil	Healthy growth	Plugging was not good but better than use of vermiculite
Vermicompost+ Vermiculite	Healthy growth	Poor plug

3.2. Effect of growing media on the tomato seedling

There was significant (P<0.001) difference in number of seedling emergence at 10 DAS among the tested growing media (Table 4). The highest number of seedling emergence (104.33) was found for the growing media Cocopeat only followed by Vermicompost+Soil (101.66),Vermicompost+Perlite (99), Vermicompost+Vermiculite (89.66), FYM+ Cocopeat + Perlite (89.33). The lowest number of seedling established were occurred in FYM+Perlite (76.66) which was at par with FYM+Soil (78.83) and FYM+Vermiculite (79.16). Similarly there was significant (P<0.001) difference in number of seedling established at 30 DAS among the tested growing media (Table 3). The highest number of seedling (103.5) was found for the growing media Cocopeat followed by Vermicompost+ Soil (99.16), Vermicompost+ Perlite (95.83), FYM+Cocopeat+Perlite (86.66), Vermicompost+Vermiculite (85.66). The lowest number of seedling established were occurred in FYM+ Perlite (72.5) which was at par withFYM+Vermiculite (74.16) and FYM+Soil (75.33).

Table 4. Effect of growing media on the no. of seedlings established and no. of leaves per seedling of tomato at HRS, Malepatan in 2020 and 2021.

Treatment	No. of seedling emergence (10 DAS)			No. of seedlings (30 DAS)			No. of leaves per seedling (30 DAS)		
	2020	2021	Mean	2020	2021	Mean	2020	2021	Mean
Cocopeat	105.00^{a}	103.66^{a}	104.33^{a}	105.00^{a}	102^{a}	103.50^{a}	4.00^{c}	5.46^{abc}	4.73^{bcd}
F+C+P	102.66^{b}	76.00^{c}	89.33^{d}	101.33^{b}	72^{c}	86.66^{d}	4.00^{c}	5.06^{abc}	4.53^{cd}
F+C+V	104.33^{ab}	61.66^{d}	83.00^{e}	103.66^{a}	55^{d}	79.33^{e}	4.46^{bc}	3.33^{c}	3.9^{d}
F+P	90.00^{e}	63.33^{d}	76.66^{g}	86.00^{e}	59^{d}	72.50^{g}	5.06^{ab}	6.86^{a}	5.96^{a}
F+S	96.00^{d}	61.66^{d}	78.83^{fg}	92.66^{d}	58^{d}	75.33^{f}	5.00^{ab}	5.26^{abc}	5.13^{abc}
F+V	78.33^{g}	80.00^{c}	79.16^{f}	73.33^{g}	75^{c}	74.16^{fg}	4.46^{bc}	4.00^{bc}	4.23^{cd}
Vermicompost+P	100.00^{c}	98.00^{b}	99.00^{c}	96.66^{c}	95^{b}	95.83^{c}	5.40^{a}	6.06^{ab}	5.73^{ab}
Vermicompost+S	103.33^{ab}	100.00^{ab}	101.66^{b}	101.33^{b}	97^{b}	99.16^{b}	4.93^{ab}	4.13^{bc}	4.53^{cd}
Vermicompost+V	80.66^{f}	98.66^{b}	89.66^{d}	76.33^{f}	95^{b}	85.66^{d}	4.80^{ab}	4.00^{bc}	4.4^{cd}
Grand Mean	95.59	82.55	89.07	92.92	78.66	85.79	4.68	4.91	4.79
SEM±	0.93	6.16	1.64	1.07	7.11	1.34	0.10	1.43	0.37
$LSD_{0.05}$	1.67***	4.29***	2.22***	1.79***	4.61***	2.01***	0.56***	2.07*	1.06*
CV%	1.01	3.00	1.44	1.11	3.38	1.35	7.00	24.38	12.77

*P<0.05, **P<0.01and ***P<0.001, CV; Coefficient of variation, LSD; Least significant difference, ±; standard error of mean (SEM), means within the column followed by the same letter are not significantly different at a 5% level of significance by DMRT.

There were significant (P<0.01) difference for the number of leaves per seedling among the tested growing media (Table 4). The highest number of leaves per seedling (5.96) was recorded for the FYM+Perlite which was at par with Vermicompost+Perlite (5.73) and FYM+Soil (5.13) followed by Cocopeat (4.73) and FYM+Cocopeat+Perlite (4.53). The lowest number of leaves (3.9) recorded for FYM+Cocopeat+Vermiculite.

There was significant (P<0.001) difference inseedling height at 30 DAS among the tested growing media (Table 5). The tallest seedling height (19.92 cm) was found in the media Vermicompost+Perlite followed by FYM+Perlite (15.78 cm) and Vermicompost+Soil (12.86 cm). The shortest seedling height occurred in Cocopeat (8.93 cm) which was at par with the growing media FYM+Cocopeat+ Vermiculite (8.97 cm) and FYM+Vermiculite (10.45 cm) and Vermicompost+ Vermiculite (11.15 cm).

The stem diameter of the seedling at 30 DAS were significant (P<0.01) among the tested growing media (Table 5). The highest stem diameter was recorded for Vermicompost+Perlite (2.93 mm) followed by FYM+Perlite (2.33 mm),Vermicompost+Soil (2.24), FYM+ Cocopeat +Vermiculite (2.13 mm), FYM+ Cocopeat + Perlite (2.06) and the smallest stem diameter was occurred in Cocopeat(1.91 mm).

Table 5. Effect of growing media on the seedling's height, stem diameter and length of roots at 30 DAS of tomato at HRS, Malepatan in 2020 and 2021.

Treatment	Plant height(cm)			Stem diameter(mm)			Root length(cm)		
	2020	2021	Mean	2020	2021	Mean	2020	2021	Mean
Cocopeat	6.83^{e}	11.02^{de}	8.93^{e}	1.96^{e}	1.86^{bcd}	1.91^{b}	7.1	10.98^{ab}	9.04^{abc}
F+C+P	7.83^{de}	16.54^{c}	12.18^{cd}	1.93^{e}	2.19^{b}	2.06^{b}	9.5	7.83^{bcd}	8.66^{abcd}
F+C+V	8.83^{bcde}	9.11^{e}	8.97^{e}	2.93^{ab}	1.33^{d}	2.13^{b}	9.76	3.66^{d}	6.71^{cd}
F+P	11.00^{ab}	20.56^{b}	15.78^{b}	2.53^{cd}	2.14^{bc}	2.33^{b}	10.39	9.86^{abc}	10.12^{ab}
F+S	10.00^{abcd}	15.07^{c}	12.53^{cd}	2.15^{e}	1.89^{bcd}	2.02^{b}	10.04	11.13^{ab}	10.58^{ab}
F+V	6.86^{e}	14.04^{cd}	10.45^{de}	2.03^{e}	2.07^{bcd}	2.05^{b}	7.71	9.10^{bc}	8.4b^{cd}
Vermicompost+P	11.83^{a}	28.02^{a}	19.92^{a}	2.63^{bc}	3.22^{a}	2.93^{a}	7.41	14.73^{a}	11.07^{a}
Vermicompost+S	10.33^{abc}	15.39^{c}	12.86^{c}	3.13^{a}	1.36^{cd}	2.24^{b}	10.04	10.97^{ab}	10.50^{ab}
Vermicompost+V	8.16^{cde}	14.14^{cd}	11.15^{cde}	2.23^{de}	1.76^{bcd}	1.99^{b}	8.08	4.81^{cd}	6.45^{d}
Grand Mean	9.07	15.99	12.53	2.39	1.98	2.18	8.89	9.23	9.06
SEM±	1.48	3.94	1.58	0.03	0.17	0.05	4.64	7.71	1.81
$LSD_{0.05}$	2.10***	3.44***	2.17***	0.31***	0.71**	0.39**	ns	4.80**	2.33**
CV%	13.40	12.42	10.04	7.50	20.80	10.54	24.22	30.08	14.86

ns; non-significant, *P<0.05, **P<0.01and ***P<0.001, CV; Coefficient of variation, LSD; Least significant difference, ±; standard error of mean (SEM), means within the column followed by the same letter are not significantly different at a 5% level of significance by DMRT.

There were found significant (P<0.01) difference among the tested growing media for the root length (Table 5). The highest length of root was recorded for the growing media Vermicompost+Perlite (11.07 cm) which was at par with FYM+Soil (10.58 cm), Vermicompost+Soil (10.5 cm) and the shortest length of root was found for the growing media Vermicompost+Vermiculite (6.45cm) which was similar with FYM+ Cocopeat +Vermiculite (6.71 cm) and FYM+ Cocopeat +Perlite (8.66cm).

3.3. Effect of growing media on the sweet pepper seedling

There was significant (P<0.001) difference in number of seedling emergence at 15 DAS among the tested growing media (Table 6). The highest number of seedling emergence (86.16) was found for the growing media Cocopeat only followed by Vermicompost + Perlite (82.66), Vermicompost+Vermiculite (81.5), FYM+Perlite (77.83), FYM+ Cocopeat + Perlite (76.33). The lowest numbers of seedling established were occurred in Vermicompost+Soil (65.5). Likewise, there was significant (P<0.001) difference in number of seedling established at 40 DAS among the tested growing media (Table 5). The highest number of seedling (83.5) was found for the growing media Cocopeat only followed by Vermicompost + Perlite (78), Vermicompost+Vermiculite (77), FYM+Cocopeat+ Perlite (73), FYM+Perlite (72.5). The lowest number of seedling established were occurred in Vermicompost+Soil (62) which was at par with FYM+ Vermiculite (63) and FYM+Soil (65.5).

Table 6. Effect of growing media on the no. of seedlings established and no. of leaves per seedling of sweet pepper at HRS, Malepatan in 2020 and 2021.

Treatment	No. of seedling emergence (15 DAS)			No. of seedlings (40 DAS)			No. of leaves per seedling (40 DAS)		
	2020	2021	Mean	2020	2021	Mean	2020	2021	Mean
Cocopeat	89.66^{a}	82.66^{b}	86.16^{a}	87^{a}	80 ^{ab}	83.5^{a}	4.93	3.53^{e}	4.23^{d}
F+C+P	86.00^{a}	66.66^{d}	76.33^{cd}	83^{b}	63^{d}	73.0^{c}	5.93	3.80^{de}	4.86^{cd}
F+C+V	87.66^{a}	61.33^{e}	74.50^{d}	84^{ab}	57^{e}	70.5^{c}	5.86	5.20^{bc}	5.53^{bc}
F+P	71.66^{d}	84.00^{ab}	77.83^{c}	66 ^{d}	79 ^{b}	72.5^{c}	5.93	6.40^{ab}	6.16^{ab}
F+S	64.33^{e}	75.00^{c}	69.66^{e}	60^{e}	71^{c}	65.5^{d}	5.13	5.53^{bc}	5.33^{bc}
F+V	79.66^{b}	58.33^{e}	69.00^{e}	74 ^{c}	52^{f}	63.0^{de}	6.13	7.33^{a}	6.73^{a}
Vermicompost+P	87.00^{a}	78.33^{c}	82.66^{b}	83^{b}	73^{c}	78.0 ^{b}	5.53	5.53^{bc}	5.53^{bc}
Vermicompost+S	61.00^{e}	70.00^{d}	65.50^{f}	58^{e}	66^{d}	62.0^{e}	6	5.60^{bc}	5.80^{bc}
Vermicompost+V	75.33^{c}	87.66^{a}	81.50^{b}	71^{c}	83^{a}	77.0^{b}	6	4.93^{cd}	5.46^{bc}
Grand Mean	78.03	73.77	75.90	74	69.33	71.66	5.71	5.31	5.51
SEM±	4.09	4.83	3.13	4.44	4.19	3.42	0.30	0.51	0.24
$LSD_{0.05}$	3.50***	3.80***	3.06***	3.64***	3.54***	3.20***	ns	1.23***	0.86**
CV%	2.59	2.97	2.32	2.84	2.95	2.58	9.62	13.46	9.02

ns; non-significant, *P<0.05, **P<0.01and ***P<0.001, *CV; Coefficient of variation, LSD; Least significant difference, ±; standard error of mean, means within the column followed by the same letter are not significantly different at a 5% level of significance by DMRT.*

There were significant (P<0.01) difference for the number of leaves per seedling among the tested growing media (Table 6). The highest number of leaves per seedling (6.73) was recorded for the FYM+Vermiculite which was at par with FYM+ Perlite (6.16) followed by Vermicompost+Soil (5.8), Vermicompost+Perlite (5.53) and Vermicompost + Vermiculite (5.46). The lowest number of leaves (4.23) recorded for Cocopeat which was at par with FYM+Cocopeat+Perlite (4.86).

There was significant (P<0.001) difference in seedling height at 40 DAS among the tested growing media (Table 7). The tallest seedling height (13.89 cm) was found in the media Vermicompost+Vermiculite which was at par with FYM+ Vermiculite (12.75 cm) followed by Vermicompost+Soil (11.74 cm) and FYM+Perlite (10.74 cm). The shortest seedling height occurred in Cocopeat (5.43 cm).

Table 7. Effect of growing media on the seedling's height, stem diameter and length of roots at 40 DAS of sweet pepper at HRS, Malepatan in 2020 and 2021.

Treatment	Plant height(cm)			Stem diameter(mm)			Root length(cm)		
	2020	2021	Mean	2020	2021	Mean	2020	2021	Mean
Cocopeat	6.50^{c}	4.36^{e}	5.43^{f}	1.56^{d}	0.51^{d}	1.04^{c}	6.13^{c}	5.88^{b}	6.01^{cd}
F+C+P	8.90^{abc}	5.56^{de}	7.23^{e}	1.83^{cd}	0.57^{d}	1.20^{c}	6.80^{bc}	3.93^{b}	5.36^{d}
F+C+V	8.86^{abc}	7.32^{d}	8.09^{e}	2.53^{ab}	0.89^{c}	1.71^{b}	7.46^{bc}	6.18^{ab}	6.82^{bcd}
F+P	10.83^{a}	10.65^{c}	10.74^{cd}	2.06^{bc}	1.23^{b}	1.65^{b}	7.13^{bc}	6.06^{ab}	6.60^{bcd}
F+S	7.10^{bc}	10.81^{c}	8.95^{de}	2.20^{bc}	1.25^{b}	1.72^{b}	7.96^{b}	4.70^{b}	6.33^{bcd}
F+V	11.66^{a}	13.84^{b}	12.75^{ab}	2.73^{a}	1.38^{ab}	2.05^{a}	9.43^{a}	5.83^{b}	7.63^{bc}
Vermicompost+P	7.66^{bc}	12.19^{bc}	9.93^{d}	2.20^{bc}	1.64^{a}	1.92^{ab}	6.66^{bc}	5.86^{b}	6.26^{bcd}
Vermicompost+S	10.70^{a}	12.79^{b}	11.74^{bc}	2.70^{a}	1.62^{a}	2.16^{a}	6.56^{bc}	9.26^{a}	7.91^{ab}
Vermicompost+V	9.70^{ab}	18.08^{a}	13.89^{a}	2.73^{a}	1.63^{a}	2.18^{a}	9.56^{a}	9.30^{a}	9.43^{a}
Grand Mean	9.10	10.62	9.86	2.28	1.19	1.73	7.52	6.33	6.93
SEM±	2.14	1.18	0.98	0.07	0.029	0.02	0.57	3.11	0.90
$LSD_{0.05}$	2.53**	1.88***	1.71***	0.46***	0.29***	0.27***	1.31***	3.05*	1.64**
CV%	16.09	10.24	10.03	11.85	14.33	9.05	10.06	27.85	13.71

, *P<0.05, **P<0.01and ***P<0.001, *CV; Coefficient of variation, LSD; Least significant difference, ±; standard error of mean, means within the column followed by the same letter are not significantly different at a 5% level of significance by DMRT.*

The stem diameter of the seedling at 40 DAS were significant (P<0.001) among the tested growing media (Table 7). The highest stem diameter recorded for Vermicompost+Vermiculite (2.18 mm) which was at par with Vermicompost+Soil (2.16 mm), FYM+Vermiculite (2.05 mm) and Vermicompost+Perlite(1.92 mm) followed by FYM+Soil (1.72 mm) and FYM+Cocopeat+ Vermiculite (1.71). The smallest stem diameter was occurred in Cocopeat (1.04 mm) which was at par with FYM+Cocopeat+Perlite (1.2 mm).

There were found significant (P<0.01) difference among the tested growing media for the root length (Table 6). The highest length of root was recorded for the growing media Vermicompost+Vermiculite (9.43 cm) which was at par with Vermicompost+Soil (7.91cm) followed by FYM+Vermiculite (7.63), FYM+Cocopeat+Vermiculite (6.82 cm) and the shortest length of root was found for the growing media FYM+Cocopeat+Perlite (5.36cm) which was at par with Cocopeat (6.01cm),Vermicompost+Perlite (6.26 cm), FYM+Soil (6.33 cm).

3.4 Discussions

The number of germination and establishment of seedling during transplanting stage was found significantly higher in the cocopeat growing media than other growing media. Use of Cocopeat as growing media have higher water holding capacity and moisture supply as well as sufficient porosity which helps better seedling emergence. Similarly, using growing media Cocopeat (50): Vermicompost (50) has higher seedling emergence, shoot height and vigor of seedlings were also reported by Hazarika *et al*., (2022); Zaller (2007); Hota and Arulmozhiselvan (2017). The difference in the number of seedling between two species might be the difference in the genetic capacity to the seedling emergence. Baiyeri and Mbah, (2006) reported that there is difference in growing media for seed germination and growth in a nursery. Growing media is a reservoir of moisture and plant nutrients (Grower, 1987). Jeevitha *et al*., (2019) reported that among the different growing media 75% Vermicompost+25% FYM media was found significantly superior for seedling production of tomato in terms of seedling height, seedling girth, leaf area, shoot length and root length. He also found higher germination for media containing 75% vermicompost and 25% Cocopeat.

Many types of growing media or substrates such as rockwool, perlite, vermiculite and peat have been used to grow many kinds of crops (Yılmaz *et al.*, 2014). Higher seedling height, number of leaves, stem diameter and root length were recordedin vermicompost and FYM during the seedling growing stage than cocopeat and use of soil. Our results are alike of Abad*et al*., (2002) which reported that a good growing medium provides sufficient support to the plant and provides sufficient nutrients and water; allow oxygen as well as gaseous exchange between the roots and atmosphere. More Seedling height observed in the use of vermicompost might be due to conducive environment as well as sufficient amount of nutrients presence in such type of media. Similar result was obtained by Hazarika *et al*. (2022) and Nissi (2018) in tomato.

The advantage of using Cocopeat has good physical properties, high total pore space, high water content, low shrinkage, low bulk density and slow biodegradation (Prasad, 1997). By using vermicompost, plant parameters like seed germination and growth, seedling girths were found significantly different with other treatments. Atiyeh *et al*., (2001) stated that vermicomposthas humic acids, plant growth promoters, N-fixing and P-solubilizing bacteria, enzymes and vitamins, which helps for increased growth, higher yield and better-quality plant products.

Vermiculite enhanced root and shoot growth and highest number of leaves in tomato and capsicum seedling growth. The result is supported by (Sihlongonyane *et al*., 2018; Parameshwarareddy *et al*., 2017; Wahome *et al*., (2011). Meena *et al*., (2017) also stated that Vermiculite and cocopeat provides adequate nutrients and enhances both the physical and biological properties and the water holding capacity of soil. Sihlongonyane *et al*., (2018) also reported that among the four growing media sand, sawdust, vermiculite and soil, the shortest stem length and lower number of leaves of tomato were recorded for soil media.

Mathowa *et al*., (2017) in sweet pepper also observed the poor performance of seedling in cocopeat only. Observation of higher stem diameter of Tomato and Capsicum by use of vermicompost with other substrate was found in similar finding of Sahni *et al*., (2008). Joshi *et al*., (2010) recorded the lowest stem diameter in tomato plants grown in soil.

4. CONCLUSION

In vegetative production, seedling stage is an important stage that has influences on growth and development, early yield, total yield and fruit per plant.The germination and seedling establishment was higher in

cocopeat growing media but other growth parameters are poor for the long period nursery until external fertilizer application was applied during growth. But use of vermicompost has great commercial potential as media for growing vegetable seedlings. Vermicompost helps in germination as well as for the plant growth for entire period in nursery without fertilizer addition. Application of perlite and vermiculite for growing media reduced the root plug during the transplanting in the main field for plastic trays. Therefore,in terms of germination and seedling health use of vermicompost or FYM in the mixed form with cocopeat or the soil as a growing media for plastic seedling trays would be sustainable technology for the farmers for commercial seedling production of vegetables rather than use of single growing media cocopeat and vermicompost.

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