

## Original Research Article

### Effect of Different Seedling Growing Media on Growth, Quality and Vigour of Tomato and Cabbage Seedling and Subsequent Performance in the Main Field

**Comment [u1]:** The topic is too long. Try to incorporate the main context with the same meaning

#### Abstract

This study, conducted during the 2018-20 rabi season at the Experimental Farm, Assam Agricultural University, Jorhat, aimed to determine the influence of various seedling growing media on tomato and cabbage seedlings' growth, quality, and field performance. Four media compositions (M1 (Cocopeat: Vermiculite: Perlite), M2 (Cocopeat: Vermicompost), M3 (Cocopeat: Vermicompost: Microbial consortium), and M4 (Conventional nursery mix of soil, sand, and FYM) were tested, alongside two crops (tomato and cabbage), resulting in eight treatment combinations. These treatments were arranged in a RBD with three replications. The study aimed to identify optimal seedling growing media for enhanced crop performance. Tomato seedlings performed best in plug trays using a coconut (50%) and vermicompost (50%) medium (M2), showing higher emergence rates, growth, and yield. Cabbage seedlings excelled with a coconut (50%), vermicompost (50%), and microbial consortium (M3) medium. Both M2 and M3 mediums also demonstrated superior field performance.

**Keywords:** Tomato, Cabbage, microbial consortium LAI, perlite, vermiculite, yield, cocopeat, vermicompost

#### **Introduction**

Tomato (*Solanum lycopersicum* L.) is a member of the Solanaceae family that is grown worldwide (Sharma and Singh, 2015). Tomato is one of the most important "protective foods" because of its special nutritive value. Tomato has been recently gaining attention in relation to the prevention of some human diseases. The focus here lies in carotenoids, particularly lycopene, an unsaturated compound. It's thought to actively contribute to cancer prevention, lowering cardiovascular risk, and slowing cellular aging (Abdel-Monaim, 2012). Lycopene is found in fresh, red-ripe tomatoes as all-trans (79-91%) and cis- (9-21%) isomers. The full potential of a transplanted vegetable can be achieved by establishing a uniform stand of healthy vigorous seedlings. Traditionally tomato seedlings are raised in the open field nursery, which confronts several adverse situations like uneven seed germination, acute seedling competition for nutrient, light and water, attack of soil-borne pest and pathogens that lead to variable seedling stand. For better seedling yields, farmers often employ high-density sowing, which can lead to increased seed expenses and resource wastage. With the adoption of hybrid variety, cost of seed has increased manifold and farmers are searching new ways to reduce seedling mortality and to get quality seedling.

Cabbage (*Brassica oleracea* L.), biennial but generally grown as annuals, is a vegetable crop, an excellent source of vitamin C, some B vitamins, potassium and calcium. The full potential of a transplanted vegetable can be achieved by establishing a uniform stand of healthy vigorous seedlings.

Traditionally, cabbage seedlings are cultivated in open field nurseries, which come with various challenges such as irregular seed germination, intense competition among seedlings for nutrients, light, and water, and susceptibility to soil-borne pests and diseases. In an attempt to obtain healthier seedlings, farmers frequently resort to high-density sowing, resulting in elevated seed costs and resource inefficiency. With the adoption of hybrid variety, cost of seed has increased manifold and farmers are searching new ways to reduce seedling mortality and to get quality seedling.

Due to the rising costs of seeds, various vegetable crops such as tomatoes, eggplants, peppers, and cucurbits are now being transplanted after nurturing in protected environments. This approach ensures maximum germination rates and robust plant establishment. While seedling production has long been employed for crops like tomatoes, peppers, cucumbers, and eggplants, it has more recently been adopted for leafy vegetables like cabbage and lettuce (Sterrett, 2001). The success of seedling production is significantly influenced by climatic conditions and the choice of seed sowing media.

During vegetative production, the seedling stage plays a pivotal role in shaping growth, development, early and overall yields, and the number of fruits per plant. Conventional methods of seedling production can impose stress on plants. The growth media used in this stage are crucial for the efficient development of horticultural seedlings in nurseries. An ideal growing medium offers stable anchorage, acts as a nutrient and water reservoir, facilitates oxygen exchange with the roots, and allows gaseous interactions between the roots and the surrounding atmosphere. The choice of growing media significantly impacts seedling quality in the nursery, which, in turn, influences field re-establishment and the ultimate productivity of an orchard (Abad et al., 2002; Baiyeri, 2006; Agbo and Omaliko, 2006).

Plug trays are emerging as suitable seedling raising technology, as tray cavities allow proper nourishment of seedling through uniform utilization of the light, water and nutrients among all the plants. Again, growing media contributed significant role on seed germination, seedling growth and initial seedling performance. In addition to traditional farmyard manure, vegetable cultivators are increasingly turning to alternative growing media for nurturing seedlings of various vegetable crops. Notably, vermicompost, cocopeat, vermiculite, perlite, and microbial consortium have gained popularity. Each of these media offers unique advantages. Cocopeat, for instance, boasts excellent physical properties, with a high total pore space, ample water retention, minimal shrinkage, low bulk density, and gradual biodegradation (Prasad, 1997). Perlite and vermiculite play a critical role in aeration and drainage, effectively storing and gradually releasing significant amounts of water as required. Vermicompost contains macro and micronutrients. It also contains humic acids, plant growth promoting substances like auxins, gibberellins and cytokinins. N-fixing and P-solubilizing bacteria, enzymes and vitamins, which increases the availability of plant nutrients resulting in increased growth, higher yield and better-quality produce (Atiyeh *et al.*, 2001). A pre-sowing inoculation of planting material as well as the planting medium with the consortia of beneficial microorganisms is an innovative approach for production of quality and healthy seedlings in horticultural production. A microbial consortium is a carrier-based product containing nitrogen fixing, phosphorus and potassium solubilizing and plant growth promoting microorganisms in a single formulation. The combined action of these formulated microbes has the potential to foster robust and healthy seedlings while significantly curbing cultivation costs by reducing the need for fertilizers in vegetable production. Comparative research on seedling performance between open-field nurseries and plug trays, as well as the effects of various growth media under greenhouse conditions in Assam, remains limited in the existing literature. This knowledge gap led to the design of the present study. Our investigation aims to assess how different seed sowing media impact the growth, quality, and vitality of cabbage seedlings, and subsequently, how they influence the yield and associated attributes of cabbage plants in the main field.

## **Materials and Methods**

The field experiments were conducted at the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat, Assam, India during rabi season of 2018-2019 and again repeated in 2019-20. The experimental site AAU, Jorhat is situated at 26.47°N latitude and 94.12°E longitude and at an elevation of 86.8 m above mean sea level. The soil was well drained sandy loam having pH 5.20, organic carbon 0.93% and available N, P and K were 212.21 kg ha<sup>-1</sup>, 20.34 kg ha<sup>-1</sup> and 118.42 kg ha<sup>-1</sup> respectively. The treatments consisted of four different nursery media composition viz. M<sub>1</sub>: Cocopeat (60): Vermiculite (20): Perlite (20), M<sub>2</sub>: Cocopeat (50): vermicompost (50), M<sub>3</sub>: Cocopeat (50):

vermicompost (50): Microbial consortium(6g/kg media), M<sub>4</sub>: Conventional nursery (soil: sand: FYM), two Crops viz. C<sub>1</sub>: Tomato (Arka Rakshak), C<sub>2</sub>: Cabbage (Rare Ball). Thus, eight treatment combinations viz. M<sub>1</sub>C<sub>1</sub>, M<sub>2</sub>C<sub>1</sub>, M<sub>3</sub>C<sub>1</sub>, M<sub>4</sub>C<sub>1</sub>, M<sub>1</sub>C<sub>2</sub>, M<sub>2</sub>C<sub>2</sub>, M<sub>3</sub>C<sub>2</sub> and M<sub>4</sub>C<sub>2</sub> were laid in Randomized Block Design (RBD) with three replications. Different seedling attributes namely seedling emergence percentage (SE %), days to 2-true leaf stage (DTLS), seedling height (SH), stem diameter (SD), leaf area (LA), days to transplant (DT), root length (RL), seedling vigour index (SVI), seedling fresh weight (SFW), seedling dry weight (SDW) and total chlorophyll content (TCC) were recorded just before transplanting. The chlorophyll content of leaves was measured by using portable leaf chlorophyll meter. The seedling vigour was calculated by multiplying the germination percentage with seedling dry weight (Abdul-Bakki and Anderson, 1973). The economics of the treatments was worked out on the basis of benefit: cost (B:C) ratio derived from net return and cost of production as per existing market rate. Healthy seedlings were transplanted in the main field at 3.0 m x 2.7 m plots at 45 cm spacing within and between rows. The field crop received a uniform dose of farmyard manure (20 t ha<sup>-1</sup>) along with recommended dose of inorganic fertilizers. Recommended cultural and plant protection measures were followed equally in all the plots as and when required. In the main field the observations were recorded on ten randomly selected plants from each plot. Two years data from different treatments were subjected to statistical analysis. The data for individual year was computed and pooled mean was worked out. The treatment means were compared using least significant difference (LSD) test at 0.05 level of significance. All analyses were performed using INDOSTAT version 8.0 statistical package

## Results and Discussion

### Performance of Tomato seedlings

The results revealed significant differences among the different seeds sowing media (Table 1, 2 & Fig 1). Growing media M<sub>2</sub> recorded higher SE (98.42%), SH (15.47 cm), SD (3.23 mm), LA (8.35 cm<sup>2</sup>), SVI (2268.54), SFW (1.53 g), SDW (0.37 g) and TCC (1.61 mg g<sup>-1</sup> fw).

All seeds need water, oxygen and right temperature to germinate. Water to soften the protective seed coat. Oxygen needed for aerobic respiration so that they can produce energy for germination and growth. The embryo gets energy by breaking down its food stores. Warm temperature is needed to speed up the chemical reaction that take place in seed and also to speed up the making of new cell when the seed embryo is growing. Inside the greenhouse proper temperature was maintained and growing media M<sub>2</sub> having good water holding capacity and moisture supply as well as sufficient porosity which permits adequate moisture and gaseous exchange between media and seed which helps better seedling emergence. Similar results were also obtained by Zaller (2007); Hota and Arulmozhiselvan (2017)

More Seedling height might be due to conducive effect of this media composition on water holding capacity, porosity, proper aeration and substantial amount of nutrient especially nitrogen and micronutrients for good plant growth (Chopde *et al.* 1999). Similar result was obtained by Nissi (2018) in tomato. Atiyeh and Coworkers (2002) pointed out that vermicompost can result in the leaf surface increase because of having enough nutrition and the absorption capability. The leaf surface increase because of the microorganism activity and pointed out that the microorganism with having the ability in producing the regulated growth material can result in the leaf surface increase. Similar result was also obtained by Nissi (2018) in tomato.

Combined application of vermicompost and cocopeat in the media M<sub>2</sub> showed more stem diameter probably due to the synergistic combinations of these factors improving the physical conditions of the media and nutritional factors (Sahniet *et al.*, 2008). It may be due to better nutrient availability leading to higher production of photosynthetically functional leaves in this treatment finally resulting in better girth of seedling (Borah *et al.*, 1994). Similar results were

erealsoobtainedbyParasana*etal.*,(2013).

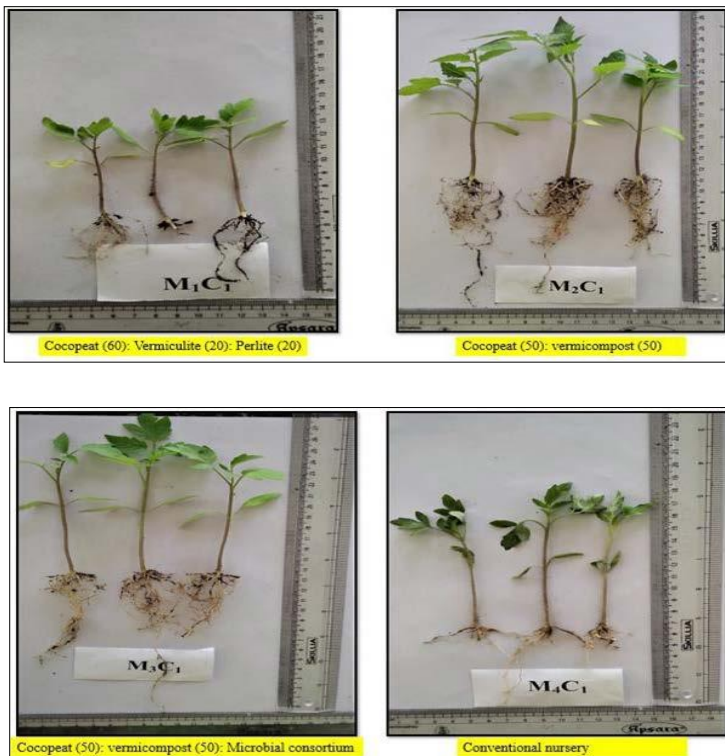
The leaves of seedling raised in this media (M2) also hashigher leaf chlorophyll content due to presence of nitrogen invermicompostwhichmightcertainlyupgradethephotosynthetic rate, dry matter production and their by morefreshand dryweight ofplant(Awashthi *etal.*,1996). The conventional nursery (soil: sand: FYM) seedlings showedbetter result than media M1 i.e Cocopeat (60): Vermiculite(20): Perlite (20) which might be due to availability of N, Pand K from FYM along with water though it is under openfield condition

**Table 1:** Pooledmean data analysis oftwoyears 2018-20 for the various traits

Treatment	SE (%)	DTLS	SH (cm)	SD (mm)	LA(cm <sup>2</sup> )	DT
M1	93.67	14.08	8.34	1.92	2.59	29.12
M2	98.42	10.35	15.47	3.23	8.35	21.38
M3	97.34	10.95	14.74	3.06	7.58	22.74
M4	94.17	16.83	11.68	2.23	2.89	28.90
S.Ed(±)	1.22	1.27	2.12	0.13	0.98	1.48
CD(0.05)	3.04	3.15	4.95	0.31	2.32	3.17

**Table 2:** Pooledmean data analysis oftwoyears 2018-20 for the various traits

Treatment	RL(cm)	SVI	SFW (g)	SDW (g)	DMA(%)	TCC (mgg-1fw)
M1	5.84	1348.64	0.51	0.09	18.83	0.81
M2	10.25	2268.54	1.53	0.37	24.18	1.61
M3	10.37	2201.28	1.49	0.35	23.74	1.28
M4	5.89	1518.91	0.56	0.10	17.83	0.73
S.Ed(±)	1.32	25.54	0.04	0.02	1.91	0.04
CD(0.05)	3.01	61.29	0.09	0.04	4.41	0.09



**Fig1:Seedling growth under different growing media**

### **Performance of Cabbage seedlings**

The results revealed significant differences among the different seed sowing media (Table 3, 4 & Fig 2). Growing media M3 recorded higher SE (92.67%), SD (3.12 mm), LA (9.15 cm<sup>2</sup>), RL (12.01 cm), SVI (2358.43), SFW (1.72 g), SDW (0.38 g) and TCC (0.99 mg g<sup>-1</sup> fw). Higher seedling emergence percent might be due to media M3 having good water holding capacity and moisture supply as well as sufficient porosity which permits adequate moisture and gaseous exchange between media and seed which helps better seedling emergence. Moreover, under greenhouse condition proper temperature was maintained which helps in emergence of seedling. Similar result was also obtained by Zaller (2007). Leaf area increased because of microbial activity. Microbial consortium contained azotobacter, azospirillum and phosphatesolubilizing bacteria and vermicompost also contain beneficial microorganisms which have the ability in producing the regulated growth material, which results in leaf area increase. Similar result was obtained by Subbaiah *et al.* (2018) in brinjal. More stem diameter might be due to better nutrient availability leading to immense production of photosynthetically functional leaves in this treatment (M3) and finally resulting in better girth of seedling.

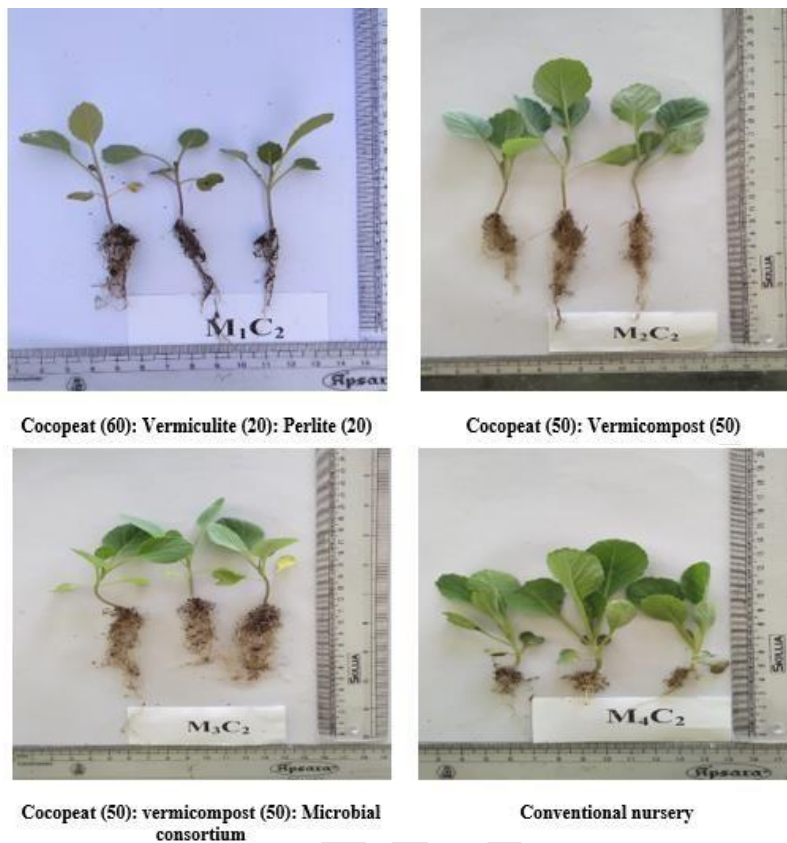
Microorganisms present in vermicompost and microbial consortium synthesize plant growth hormones mainly auxin, gibberellin and cytokinin. The maximum root growth might be due to more availability of auxin in this growing media (M3). The obtained results are agreed in somewhat with Ngaatendwe *et al.* (2015). Higher vigour index was found in media (M3) might be due to increased germination and seedling height which have contributed to greater vigour index. The results of study are in close agreement with the findings of Prajapati *et al.* (2017) and Parasana *et al.* (2013).

**Table 3:** Seedling emergence (%), days to 2-True leaf stage, seedling height and stem diameter  
(Pooled mean of two years 2018-19 and 2019-20)

Treatment	SE (%)	DTLS	SH (cm)	SD (mm)	LA (cm <sup>2</sup> )
M1	83.56	12.72	7.08	2.0 1	4.68
M2	90.45	10.59	10.90	3.0 2	8.87
M3	92.67	10.21	10.35	3.1 2	9.15
M4	91.78	13.66	9.15	2.5 6	8.04
S.Ed(±)	2.38	0.39	0.59	0.0 7	0.77
CD(0.05)	5.95	0.87	1.26	0.2 1	1.46

**Table 4:** Days to transplant, Root length, Seedling vigour index, Seedling fresh weight, Seedling dry weight and Total Chlorophyll content(Pooled mean of two years 2018-20)

Treatment	DT	RL (cm)	SVI	SFW (g)	SDW (g)	TCC(mgg <sup>-1</sup> fw)
M1	27.19	5.68	1264.61	0.72	0.14	0.80
M2	22.62	8.82	2175.26	1.64	0.36	0.93
M3	22.54	12.01	2358.43	1.72	0.38	0.99
M4	29.57	4.51	1384.83	1.18	0.23	0.78
S.Ed(±)	1.65	1.23	42.68	0.06	0.03	0.03
CD(0.05)	4.10	3.46	101.50	0.15	0.07	0.06



**Fig 2:** Seedling growth under different growing media

#### **Performance of Tomato seedling in the main field**

The seedling raised media M2 under greenhouse condition showed better performance in the main field, recorded less days (4.29) to SE, more PH (70.43, 95.30 and 118.50 cm) after 30, 60 and 90 DT, higher LAI (5.45), higher RL (60.53 cm), less days required for DF (31.71), 50% fruit set (46.89) and harvesting (93.69 days), higher individual fruit weight (66.78g), higher fruit yield per plant (2.85 kg) and higher yield per hectare (105.63t) and B:C ratio (5.28) (Table: 5, 6, 7 & 8).

Successful establishment of a seedling in the main field is the first critical step for crop production. Early establishment might be due to more root length which quickly absorb water and nutrients and high seedling vigour index. This active root system allows more uniform and faster growth, with little or no transplant shock. Increase in number of leaves might be mainly due to corresponding increase in plant height (Govind and Chandra, 1993) and also may be due to better nutrient availability leading to immense production of photosynthetically functional leaves in these treatments (Patel *et al*, 2019). LAI is an important parameter in plant ecology. Because it tells how much foliage is there, it is a measure of the photosynthetic active area. More LAI might be due to more leaf number in the plant. Roots are a lifeline of a plant, taking up air (O<sub>2</sub>), water and nutrient from soil and moving them up to the leaves. More root length might be due to more photosynthates transferred to the root because leaf area index is more in this treatment and more leaf area index more photosynthesis *i.e* more food production for plant. The more fruit weight might be due to production of a greater number of leaves. More leaf area index was also found in this treatment M2 due to which photosynthesis is increased and finally increased the fruit weight. Similar result was

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given by Jett *et al.*,(1995) inbroccoli.

**Table 5:** Days to establishment, Plant height at 30, 60 and 90 days after transplanting, leaf number, leaf area, leaf area index and specific leafweight(Pooledmean oftwoyears 2018-19 and2019-20)

Treatment	Days to establishment	Plant height (cm)at30DAT	Plant height (cm)at60DAT	Plant height (cm)at90DAT	Leaf numbers	Leaf area index (LAI)	Specific leaf weight (mg cm <sup>-2</sup> )
M1	5.83	51.68	85.23	100.78	30.84	3.29	8.29
M2	4.29	70.43	95.30	118.50	41.56	5.45	18.22
M3	4.41	60.70	93.94	114.74	38.77	5.20	19.59
M4	6.21	55.37	89.86	103.34	35.08	4.67	13.45
S.Ed(±)	0.77	6.16	2.39	4.75	2.37	0.33	2.82
CD(0.05)	1.69	13.61	5.99	9.90	5.37	0.65	5.67

**Table 6:** Membrane stability index, relative leaf water content, root length, root dry weight, days to 50% flowering, days to 50% fruit set and no.offlowerclusterper plant (Pooled mean oftwoyears2018-19and 2019-20)

Treatment	Membrane stability index(%)	Relative leafwater content (%)	Root length (cm)	Root dry weight (g)	Days to50% flowering	Days to50% fruit set
M1	62.73	77.24	38.45	12.38	35.67	56.22
M2	70.71	79.48	60.53	15.95	31.71	46.89
M3	66.91	77.20	54.77	15.95	32.80	46.92
M4	57.59	78.78	40.10	11.46	37.26	50.55
S.Ed(±)	2.39	0.86	4.25	1.12	0.83	2.83
CD(0.05)	4.06	1.17	7.76	2.70	1.78	6.37

**Table 7:** No. of fruits per cluster, Head weight, head diameter, head compactness, head yield and B:C ratio (Pooled mean of two years 2018-19 and 2019-20)

Treatment	No. of flower cluster per plant	No. of fruits per cluster	Days to first harvest	Individual fruit weight (g)	Fruity yield per plant (kg)	Total yield (tha-1)
M1	9.65	5.12	109.51	59.77	2.04	75.29
M2	10.78	6.37	93.69	66.78	2.85	105.63
M3	10.83	6.15	99.29	65.57	2.73	101.01
M4	10.22	5.32	107.06	58.71	2.15	79.73
S.Ed(±)	0.24	0.13	2.58	0.87	0.15	1.89
CD(0.05)	0.45	0.24	5.35	1.91	0.55	4.72

**Table 8:** Production economics of tomato (Pooled mean of two years 2018-19 and 2019-20)

Treatment	Gross expenditure (Rs.ha-1)	Gross return (Rs. ha-1)	Net return (Rs.ha-1)	B:C ratio
M1	261446	1129350	867904	3.32
M2	252398	1584450	1332052	5.28
M3	252554	1515150	1262596	4.99
M4	239762	1195950	956188	3.98





**Fig3:** Tomato Fruit cluster under different treatments

#### *Performance of Cabbage seedling in the main field*

The seedling raised media M3 [Cocopeat (50): vermicompost(50):Microbial consortium] under greenhouse conditions showed better performance in the main field, recorded less days to seedling establishment (3.34), more plant height (21.84 cm) after 30 days of transplanting, higher leaf area index (12.16), higher root length (22.07 cm), higher no. of wrapping leaves (37.45), less days required to head initiation (41.64) and harvesting (62 days), higher head weight (1.58kg), higher head diameter (15.91cm), head compactness (4.09) and higher head yield per hectare (77.42 t) and B:Cratio (3.88). (Table 9, 10 and 11)

**Table 9:** Days to establishment, Plant height at 30 and 60 days after transplanting, leaf number, leaf area and leaf area index (Pooled mean of two years 2018-19 and 2019-20)

Treatment	Days to establishment	Plant height (cm) at 30 DAT	Plant height (cm) at 60 DAT	Leaf numbers	Leaf area index (LAI)
M1	4.29	17.00	26.27	38.03	8.89
M2	3.36	21.35	29.73	48.03	10.39
M3	3.34	21.84	29.27	49.18	12.16
M4	5.41	17.69	26.68	39.52	9.31
S.Ed(±)	0.54	0.65	0.71	4.68	0.86
CD(0.05)	1.17	1.40	1.61	10.68	1.84

**Table 10:** Root length, root dry weight, no. of non-wrapping and wrapping leaves, days to head initiation and days to harvesting (Pooled mean of two years 2018-19 and 2019-20)

Treatment	Root length (cm)	Root dry weight (g)	No. of non-wrapping leaves	No. of wrapping leaves	Days to head initiation	Days to harvesting
M1	17.28	12.83	10.01	28.02	43.41	67.23
M2	20.29	15.25	11.48	36.55	41.89	62.77
M3	22.07	16.20	11.73	37.45	41.64	62.00
M4	17.02	12.21	10.13	29.39	42.73	65.89
S.Ed(±)	0.61	0.82	0.68	0.53	0.77	2.21
CD(0.05)	1.33	1.83	1.53	1.15	1.58	5.16



Cocopeat (60): Vermiculite (20): Perlite (20)



Cocopeat (50): Vermicompost (50)



Cocopeat (50): Vermicompost (50): Microbial consortium



Conventional nursery

Fig 4 : Cabbage at head initiation stage under different treatments

Table 11: Headweight, headdiameter, headcompactness, headyieldandB:Cratio(Pooledmean oftwoyears2018-19and2019-20)

Treatment	Head weight(kg)	Headdiameter(cm)	Headcompactness	Head yield( $\text{tha}^{-1}$ )	B:C ratio
M1	1.21	13.08	6.12	59.29	2.54
M2	1.51	14.87	5.13	73.99	3.67
M3	1.58	15.91	4.09	77.42	3.88
M4	1.31	13.01	6.85	64.43	3.55
S.Ed( $\pm$ )	0.12	0.47	0.49	0.96	-
CD(0.05)	0.26	1.04	1.07	2.08	-



Cocopeat (60): Vermiculite (20): Perlite (20)



Cocopeat (50): Vermicompost (50)

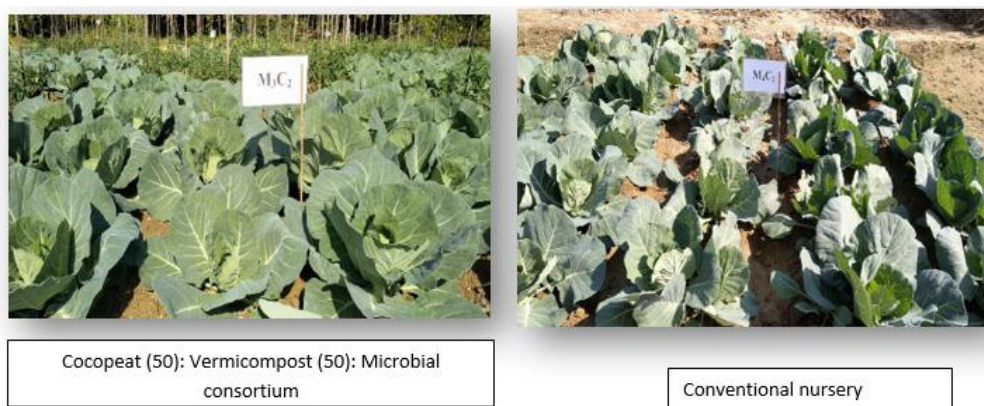


Fig 5 : Cabbage at vegetative stage under different treatment

### Conclusion

The result of the present investigation revealed that seedling raising in cocopeat (50): vermicompost (50) i.e media M2 and cocopeat (50): vermicompost (50): Microbial consortium i.e media M3 in greenhouse are an efficient and superior alternative to traditional open field seedling raising (M4 : conventional nursery) for tomato and cabbage. These method offers great potential for healthy and vigorous seedlings production in tomato and cabbage which finally shows better performance in the main field in terms of yield and yield attributing characters.

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