The Pharma Innovation Journal 2023; 12(6): 3986-3991

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(6): 3986-3991

www.thepharmajournal.com
Received: 10-04-2023
Accepted: 14-05-2023

Roopali Patel
Ph.D. Research Scholar, Department of Horticulture, College of Agriculture, Assam Agricultural University, Jorhat, Assam, India

Deepa B Phookan
Professor, Department of Horticulture, College of Agriculture, Assam Agricultural University, Jorhat, Assam, India

Sailen Gogoi
Principal Scientist, Department of Horticulture, College of Agriculture, Assam Agricultural University, Jorhat, Assam, India

Prakash Kalita
Professor, Assam Agricultural University, Jorhat, Assam, India

Anjali Basumatary
Professor, Department of Soil Science, College of Agriculture, Assam Agricultural University, Jorhat, Assam, India

IS Naruka
Professor, Horticulture and Associate Director Research, RVSKVV, Gwalior, Madhya Pradesh, India

Samiksha
Assistant Professor, Rajiv Gandhi Central Agriculture University, Itanagar, Arunachal Pradesh, India

Corresponding Author:
Roopali Patel
Ph.D. Research Scholar, Department of Horticulture, College of Agriculture, Assam Agricultural University, Jorhat, Assam, India

Efficacy of sowing media for quality planting material production of Broccoli (*Brassica oleracea* var. *italica* L.) under Jorhat conditions of Assam-India

Roopali Patel, Deepa B Phookan, Sailen Gogoi, Prakash Kalita, Anjali Basumatary, IS Naruka and Samiksha

Abstract
An experiment was conducted at Horticulture Experimental Farm, Department of Horticulture, College of Agriculture, Assam Agricultural University, Jorhat, Assam during the year 2020-21 and 2021-22 for knowing the potentiality of different seedling growing media *viz*., Cocopeat: Perlite: Vermiculite (3:1:1), Cocopeat: Perlite: Vermiculite (2:1:1), Cocopeat: Vermicompost (1:1),Vermicompost: Perlite: Vermiculite (3:1:1), Vermicompost: Perlite: Vermiculite (2:1:1), Cocopeat: Vermicompost: Perlite: Vermiculite (1:1:1:1) and Conventional nursery. These seven treatments were analyzed in RBD with 4 replications. The higher seedling emergence percentage (93.15), seedling height (17.87 cm), leaf area (9.09 cm^2), root length (6.04 cm), shoot length (10.24 cm), seedling growth index (1516.35), chlorophyll content (0.32 mg g^{-1}fw), minimum days to two-true leaf stage (7.03 days), minimum days to transplanting (28.55 days) and the lowest diseases incidence (3.44%) under the greenhouse condition was recorded in the treatment T_3 [(Cocopeat: Vermicompost (1:1)]. While the highest stem diameter (1.85 mm) was observed in T_6 [Cocopeat: Vermicompost: Perlite: Vermiculite (1:1:1:1].

Keywords: Broccoli, seedling, sowing media, seedling parameter

Introduction
Broccoli (*Brassica oleracea* var. *italica* L.) is an important and highly exotic and nutritious vegetable. It is a member of the cruciferous family. It is also known as winter broccoli and heading broccoli. It is considered to be originated from wild cabbage. *Brassica oleracea* var. *oleracea* (syn. *Brassica oleracea* var. *sylvestris* L), which is growing alone in the Mediterranean Sea. Broccoli has large flower curds arranged in a tree- like structure on branched sprouts growing from a thick, edible stalk. Broccoli is a high-quality vegetable for fresh use and is one of the most popular frozen vegetables. It is also used as a vegetable in many other countries, such as Spain, Mexico, Italy, France and the United States. Broccoli production in India 674 tones from an area of 369 hectare (Anonymous, 2018). India is the second largest producer of broccoli after China. Nutritionally, it is rich in vitamin-A (2500 I.U.), vitamin C (113 mg), protein (3.6 g), carbohydrates (5.9 g) and minerals like calcium (103 mg), iron (1.1 mg), phosphorous (78 mg), potassium (382 mg) and sodium (15 mg) per 100 g of an edible portion (Rana, 2008) [14].
The growing media is important for seed germination and also a source of key nutrients for plant growth. The composition of the medium influences the quality of the seedlings (Wilson *et al*., 2001) [20]. For a plant to strengthen its new root system there must be a ready supply of moisture and oxygen for growth of all living cells. Coarse-textured media often meet these requirements. Most commercially prepared mixes are termed “artificial”, which means they contain no soil. Artificial growing media are materials other than soils in which plants are grown. These can include organic materials such as compost, peat, cocopeat, vermicompost, and tree bark, or inorganic materials such as clay, vermiculite, minerals, rock wool, etc. (Vaughn *et al*., 2011) [19].
Growing media is an organic or inorganic material that gives the root system anchorage to the plants. For plant metabolism, growth, and development, it provides the necessary plant nutrients. Growing media is an integral part of most systems of crop development. Availability in large quantities along with its excellent conservation of air and water, low pH and salinity, and freedom from pests and diseases has led to the dominance of growing media in many parts

of the world in the last 50 years. Several growing media such as cocopeat, perlite, vermiculite, rock wool, sawdust, and compost were found to be individually or in combination suitable for high-value crops such as broccoli, tomato, capsicum, and cucumber. The soil is generally used as a basic medium because it is easily available and cheap for supplementing the soil, which is aimed to make media more porous (vermiculite, perlite, cocopeat etc.) while the organic matter (vermicompost) is added so as to supplement adequate nutrients for the seedling. The Growing media have three main functions: 1) provide aeration and water, 2) allow for maximum root growth and 3) physically support the plant. The growing medium should have adequate pore space between the particles (Bilderback *et al*., 2005) [5]. Appropriate particle size selection or combination is critical for a light and fluffy (well-aerated) medium that promotes fast seed germination, strong root growth and adequate water drainage.

Material and Methods

The present investigation was conducted in the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat during 2019-2020 and 2020-21. The methodology followed and the materials used in the present study are detailed below.

Treatment detail (Nursery Media composition)

Treatment	Components	Ratio
T_1	Cocopeat: Perlite: Vermiculite	(3:1:1)
T_2	Cocopeat: Perlite: Vermiculite	(2:1:1)
T_3	Cocopeat: Vermicompost	(1:1)
T_4	Vermicompost: Perlite: Vermiculite	(3:1:1)
T_5	Vermicompost: Perlite: Vermiculite	(2:1:1)
T_6	Cocopeat: Vermicompost: Perlite: Vermiculite	(1:1:1:1)
T_7	Conventional nursery	-

All the observed data were statistically analyzed by the method of analysis of variance describe by Panse and Sukhatme (1978). The data obtained from different treatments during field experimentation were subjected to the analysis of variance by Randomized Block Design. The size of plot was 3.60 m x 3.15 m and the total experimental area was 330 sq. m. The space between replications was 60 cm and between plots was 50 cm. The plant population in each plot was 42.

Fig 1: Overview of experimental plot

Result and Discussion

Seedling emergence (%)

The result reveals that significant differences were observed among the different seed-sowing media (Table 1) during the periods of investigation. Sowing media T_3 [(Cocopeat: vermicompost (1:1)] recorded the highest seedling emergence *i.e.*, 92.68%, 93.62% and 93.15% in the two years and pooled data respectively. However, T_3 was at par with T_6 [Cocopeat: Vermicompost: perlite: vermiculite (1:1:1:1)]. The Lowest seedling emergence percentage (81.33%) was observed in the sowing media T_7 (Conventional nursery). Baiyeri and Mbah (2006) [21] reported that the sowing media affect the seed germination and the succeeding emergence of seedlings in the nursery. Grower (1987) also reported that the sowing media is a reservoir of moisture and plant nutrients. A combined application of Cocopeat and Vermicompost (1:1) showed a significant effect on tomato seedling emergence, due to a synergistic combination of both the factor in improving the physical condition of the media and nutritional factors. Similar results were also found by Shani *et al.*, (2008) [16] in tomato seedling.

Days to Two –True leaf stage

Data presented in Table 1 and figure 2 showed the significant effect of sowing media on days to two -true leaf stage in both the years of investigation. Seedlings grown inside protected conditions showed better performance compared to the seedlings grown in a conventional nursery. Table 1 presented the days taken to attain two true leaf stages in different treatments. From the table, it is observed that there was a significant difference among the treatments. The media in the T_3 [(Cocopeat: vermicompost (1:1)] treatment took significantly minimum days (7.03) than the other media, followed by T_6 [(Cocopeat: vermicompost: perlite: vermiculite (1:1:1:1)], 7.11 days and T_4 [(Vermicompost: perlite: vermiculite)] 7.37 days. Statistically these treatments were at par with each other. Seedlings that emerged in the conventional nursery took 8.60 days which was significantly the highest among the treatments. Similar results were found by Hazarika *et al*., (2022) [8] observed the least time (10.35 days) taken for the two-true leaf stage in the growing media containing [(Cocopeat (50): Vermicompost (50)] in tomato seedlings production. Significant effect of cocopeat and vermicompost (1:1) were also reported by Mota *et al*., (2009) [9] in tomato seedling, they stated that increased growth and biomass of seedlings perhaps due to better air-filled porosity, easy establishment, and good water-holding capacity of cocopeat and vermicompost.

Table 1: Efficacy of sowing media for Seedling emergence (%), Days to two true leaf stage and Days to transplanting of Broccoli

Treatment	Seedling emergence (%)			Days to two true leaf stage			Days to transplanting		
	2019-2020	2020-2021	Pooled	2019-2020	2020-2021	Pooled	2019-2020	2020-2021	Pooled
T_1	89.90	88.13	89.01	8.32	8.16	8.24	34.33	32.50	33.42
T_2	82.40	82.66	82.53	7.82	8.12	7.97	32.00	32.50	33.67
T_3:	92.68	93.62	93.15	6.90	7.16	7.03	28.00	29.10	28.55
T_4:	87.47	87.37	87.42	7.24	7.49	7.37	31.67	30.17	30.92
T_5:	86.87	85.90	86.38	7.61	8.11	7.86	32.00	30.67	31.33
T_6:	91.19	91.00	91.10	7.02	7.20	7.11	30.33	29.33	29.83
T_7:	81.43	81.23	81.33	8.53	8.67	8.60	35.67	36.00	35.83
S. Ed (±)	1.57	2.05	1.19	0.38	0.34	0.24	1.42	1.60	1.02
CD (0.05)	3.42	4.46	2.42	0.83	0.74	0.49	3.10	3.49	2.07

Days to transplanting

Results from Table 1 revealed that there were significant differences among the treatments for days taken to transplanting. Among the treatments, T_3 [(Cocopeat and

vermicompost(1:1)] required less time of 28.00, 29.10 and 28.55 days in the first year, second year and pooled data of two years respectively to attain transplantable stage. Next to T_3, the treatment T_6 [(Cocopeat: vermicompost: perlite: vermiculite (1:1:1:1)] took 29.83 days to attend the transplantable stage. However, both the treatments were statically at par with each other. Seedlings produced in conventional nursery took the highest days of 35.67, 36.00 and 35.83 in the first year, second year and pooled data respectively to attain the transplantable stage. Sowing media containing Cocopeat and vermicompost at 1:1 was effective in the root system, due to better interchangeability of the elements especially cations inside the substrates and proper moisture distribution in the root system and finally contribute in increased seedling height. (Bhardwaj. 2013) [4] also reported the same results in papaya. Similar findings were also reported by Hazarika *et al*., (2022) [8] in cabbage seedling production by using cocopeat and vermicompost (50:50) as seed-sowing media.

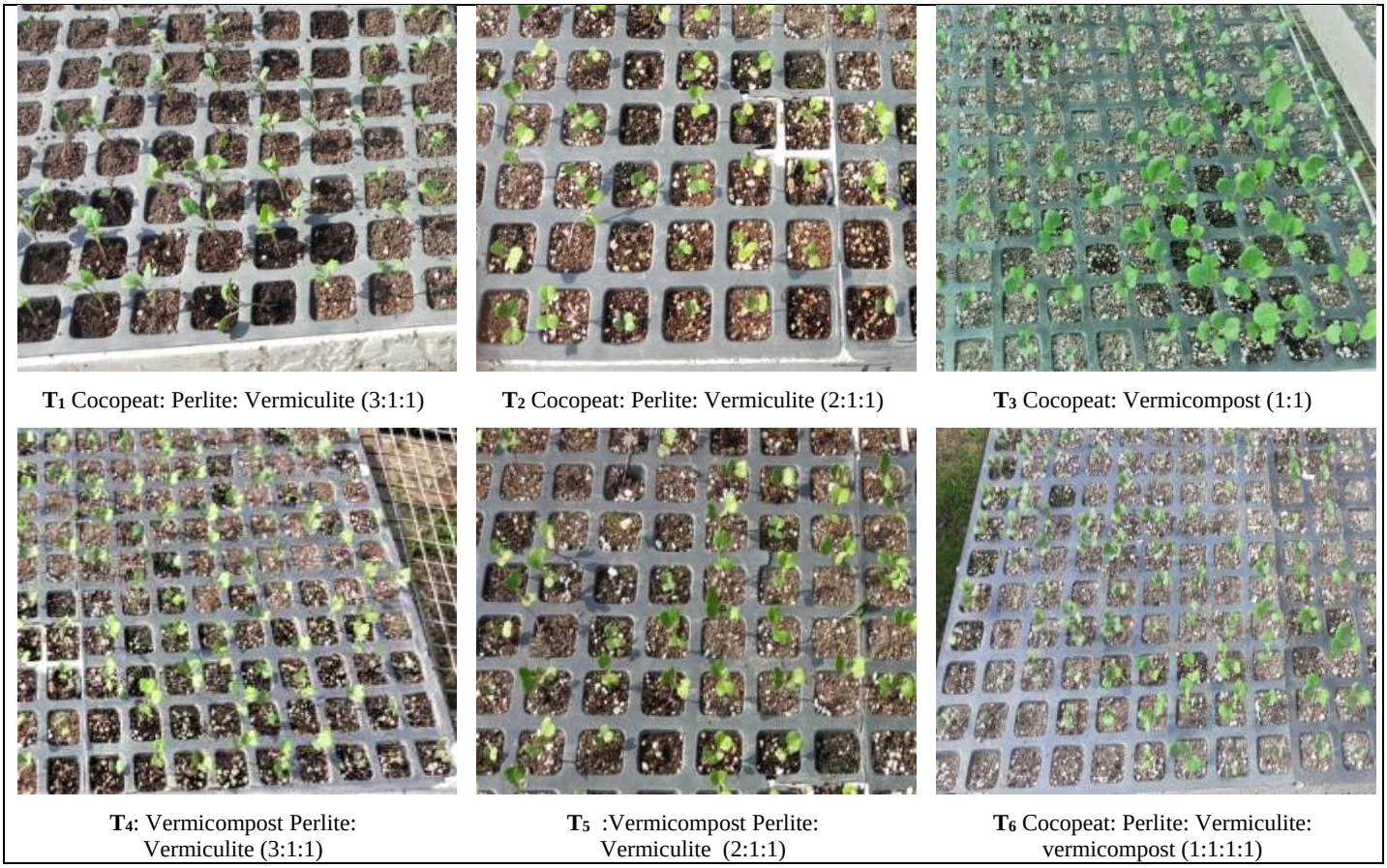

Fig 2: Days to 2 true leaf stage under difference sowing media

Table 2: Efficacy of sowing media for Seedling height (cm), Leaf area (cm^2) and Stem diameter (mm) of Broccoli

Treatment	Seedling height (cm)			Leaf area (cm^2)			Stem diameter (mm)		
	2019-2020	2020-2021	Pooled	2019-2020	2020-2021	Pooled	2019-2020	2020-2021	Pooled
T_1:	13.5	14.62	14.06	5.39	4.92	5.16	1.66	1.77	1.72
T_2:	13.7	14.34	14.02	4.57	4.33	4.45	1.58	1.75	1.67
T_3:	17.5	18.25	17.87	9.27	8.91	9.09	1.72	1.78	1.75
T_4:	15.32	15.72	15.52	6.55	7.2	6.88	1.59	1.63	1.61
T_5:	14.3	14.72	14.51	7.36	5.43	6.4	1.7	1.63	1.65
T_6:	16.85	17.83	17.34	8.94	7.38	8.16	1.84	1.86	1.85
T_7:	13.38	13.97	13.67	3.97	3.8	3.88	1.54	1.69	1.61
S. Ed (±)	0.39	0.21	0.11	0.40	0.44	0.38	0.07	0.09	0.06
CD (0.05)	0.85	0.47	0.24	0.89	0.97	0.79	0.17	0.19	0.11

Seedling height (cm)

The results revealed that seedling height showed significant differences among the treatments of seed-sowing media (Table 2 and Fig. 3). Among them the highest seedling height (17.87cm) was recorded in T_3 [(Cocopeat and vermicompost (1:1)] which was closely followed by T6 (17.34cm) [(Cocopeat: vermicompost: perlite: vermiculite (1:1:1:1)], and the lowest seedling height (13.67cm) was recorded in the sowing media T_7 (conventional nursery). More seedling height might be due to the conductive effect of the media on compositing, water holding capacity, porosity, proper aeration, and contributing substantial amount of nutrients, especially nitrogen and micronutrient for good plant growth (Chopde *et al*., 1999) [7]. Similar results were also reported by Paul and Metzger (2005) [25] with the vermicompost as a sowing media in a plug tray for enhanced seedling attributes

in brinjal. Vermicompost provides the moisture and nutrient properly to emerge seedlings and contributes to the production of healthy and vigorous seedlings (Singh *et al*., 2007 and Alex *et al*., 2007) [17, 2].

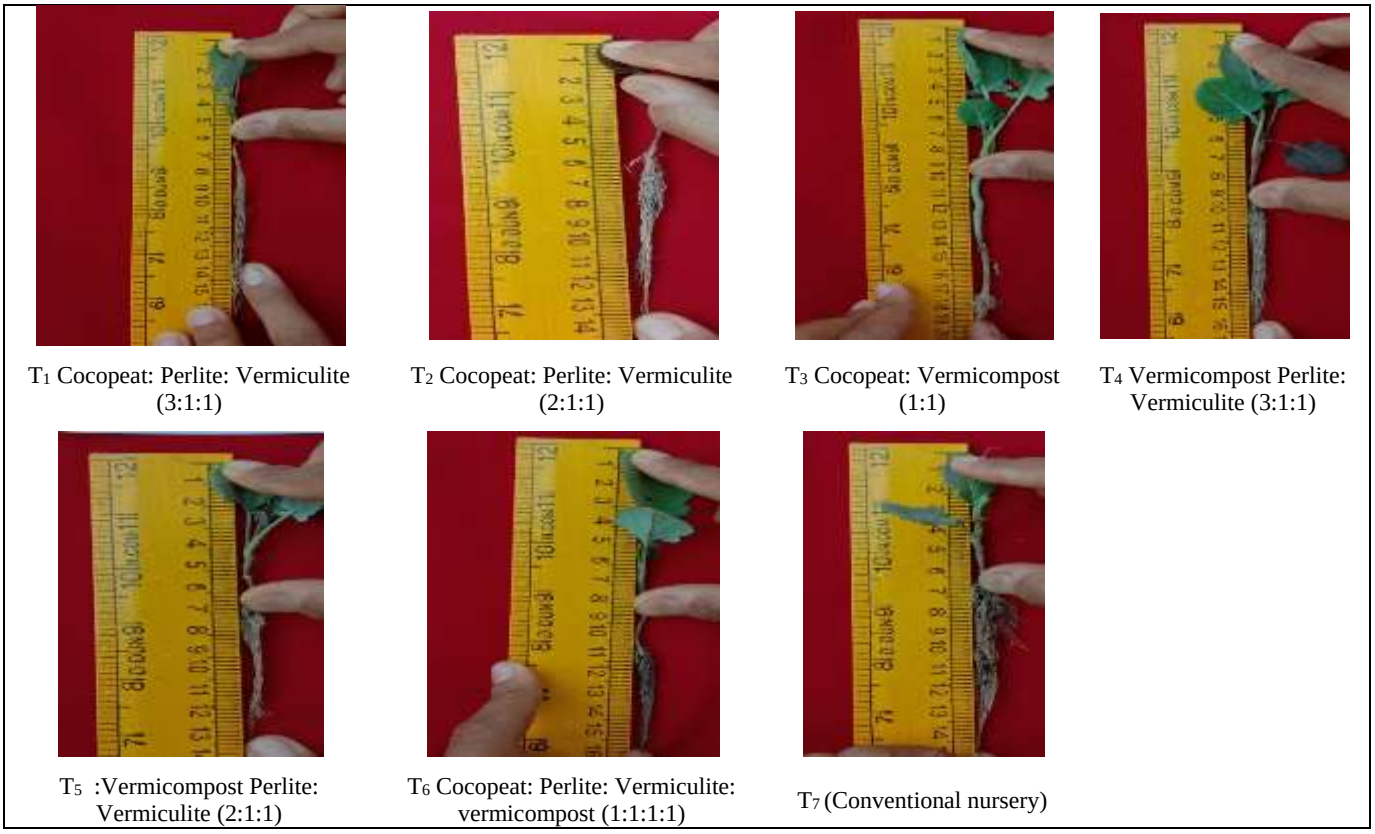

Fig 3: Seedling height of broccoli under different growing media

Leaf area (cm^2)

Table 2 showed the significant differences in the leaf area of broccoli seedlings in various sowing media treatments. The highest leaf area of 9.27cm^2, 8.91cm^2 and 9.09cm^2 was recorded in T_3 [(Cocopeat: vermicompost (1:1)] in the first, second years and pooled data respectively. The second highest leaf area of 8.16cm^2 was observed in T_6 [(Cocopeat: vermicompost: perlite: vermiculite (1:1:1:1)]. The minimum leaf area of 3.97 cm^2, 3.80cm^2 and 3.88 cm^2 in the first, second and pool data analysis was recorded in T_7 (conventional nursery).

Atiyeh *et al*., (2001) [22] suggested that vermicompost can result in an increase in leaf surface area, because of having good absorption ability to produce the enough nutrition content. Vermicompost is having good microbial activity and the ability to produce growth-regulated materials resulting in an increased leaf surface. Similar findings were also reported by Nissi (2018) [23] on seedlings of tomatoes.

Stem diameter (mm)

Table 2 represented the two years as well as pooled data on the stem diameter of the broccoli seedlings. The maximum stem diameter was recorded in T_6 (1.85 mm) sowing media [(Cocopeat: vermicompost: perlite: vermiculite (1:1:1:1)] followed by (1.75 mm) T_3 [(Cocopeat: Vermicompost (1:1)]. These treatments were statistically at par with each other. The treatment T_7 (conventional nursery) recorded a minimum stem diameter of 1.61 mm.

(Borah *et al*., 1994) [24] reported that coconut husk is having high cation exchangeability and good water-holding capacity. Vermicompost improves the plant growth with the most positive effect in the media containing 10% and 20% by volume and small Particle size with good drainage ability, moisture retention capacity, and better nutrient availability contributing to higher production of photo synthetically functional leaves in this treatment and finally resulted in better girth of seedlings. Similar results were also reported by Patel *et al*., (2019) [12].

Root length (cm)

Table 3 and Fig. 4 reveals the root length of the seedlings in various seed-sowing media. Pooled data of two years showed the highest root length of 6.04 cm in T_3 [Cocopeat: Vermicompost (1:1)], which was closely followed by T_6 [(Cocopeat: vermicompost: Perlite: Vermiculite (1:1:1:1)] with the root length of 5.75 cm. However, the treatment T_3 and T_6 was non-significantly differing from each other. Treatment T_4 (4.89 cm) [(Vermicompost: Perlite: vermiculite)] and T_5 (4.75) [(Vermicompost: Perlite: Vermiculite)] were also found at par with the each other. The lowest root length of 2.69 cm was recorded in T_7, i.e., seedlings raised in the conventional nursery.

The increase in root length was due to the addition of organic matter [(Cocopeat: Vermicompost (1:1)] which enhanced the sowing media structure and created conducive conditions for better development of roots. These findings were also supported by Arisha *et al*., (2003) [26] in pepper seedlings.

According to Hartmann and Kester (1997) Sowing medium of (soil: sand: vermicompost: vermiculite: cocopeat (1:1:1:1:1) provide good soil texture, structure, porosity water holding capacity, the activity of useful soil micro flora and fauna, maintained the soil temperature and improvement in the soil

health and nutrient status of medium. Cocopeat and vermicompost also provide better aeration for the root zone and moisture supply facilitate the root respiration and encourages root growth.

Root number

The data presented in Table 3 shows that root numbers significantly differ among the various treatments. In the first year of the experiment, the highest root number was found in T_6 [(Cocopeat: Vermicompost: Perlite: Vermiculite (1:1:1:1)] 9.25 followed by 9.15 root number in T_3 [(Cocopeat: Vermicompost (1:1)] and the lowest 8.07 root number was recorded in T_7. Similar trends were also observed in the second year. However, the pooled data of from the two years of the analysis show the non-significant results.

Vermicompost provides close contact between seed and media and increases moisture supply that facilitates root respiration and cocopeat provides better aeration in the root zone which encourages overall root growth in moringa seedlings (Chatterjee *et al.*, 2007) [6]. These findings are in close conformity with the findings of Subbaiah *et al.*, (2018) [18] in brinjal seedling. Bachman *et al*., (2008) [3] also reported that vermicompost is a bioactive substance, considered to be beneficial for root initiation and growth of plants.

Shoot length (cm)

Significant differences were found in shoot length (Table 3) in the first and second years of experiments. The highest shoot length (10.30 cm) was recorded in T_3 sowing media [(Cocopeat: Vermicompost (1:1)] in the first year followed by 10.23 cm in T_6 [(Cocopeat: Vermicompost: Perlite: Vermiculite (1:1:1:1)]. In the second year, the highest shoot length of 10.21cm was observed in T_6 followed by 10.18cm in T_3. In both years the lowest shoot length was recorded in T_7 (Conventional nursery). However, the pooled data analysis observed non-significant. Coir dust is low in nutrients but this dust when mixed with vermicompost; it provides a better growth medium for plant establishment due to the air-filled porosity (AFP), easily available water (EAW) and proper aeration in the growing media. These all factors affect the seedling growth, stem diameter, root and shoot length (Abirami *et al*., 2010) [1].

Table 3: Efficacy of sowing media for root length (cm), root number and shoot length (cm) of Broccoli

Treatment	Root length (cm)			Root number			Shoot length (cm)		
	2019-2020	2020-2021	Pooled	2019-2020	2020-2021	Pooled	2019-2020	2020-2021	Pooled
T_1	3.88	3.85	3.86	8.66	9.27	8.81	8.90	9.00	8.95
T_2	4.18	3.86	4.02	8.09	9.13	8.61	8.12	8.72	8.42
T_3:	6.27	5.81	6.04	9.15	9.30	9.23	10.30	10.18	10.24
T_4:	4.93	4.85	4.89	9.10	9,23	9.17	9.27	9.12	9.20
T_5:	4.74	4.75	4.75	8.72	9.15	8.94	8.87	8.80	8.86
T_6:	5.85	5.65	5.75	9.25	9.33	9.29	10.23	10.21	10.22
T_7:	3.23	2.15	2.69	8.07	7.73	7.90	7.56	7.50	7.53
S. Ed (±)	0.14	0.06	0.15	0.33	0.11	1.61	0.14	0.11	1.66
CD (0.05)	0.31	0.14	0.33	0.71	0.24	NS	0.29	0.23	NS

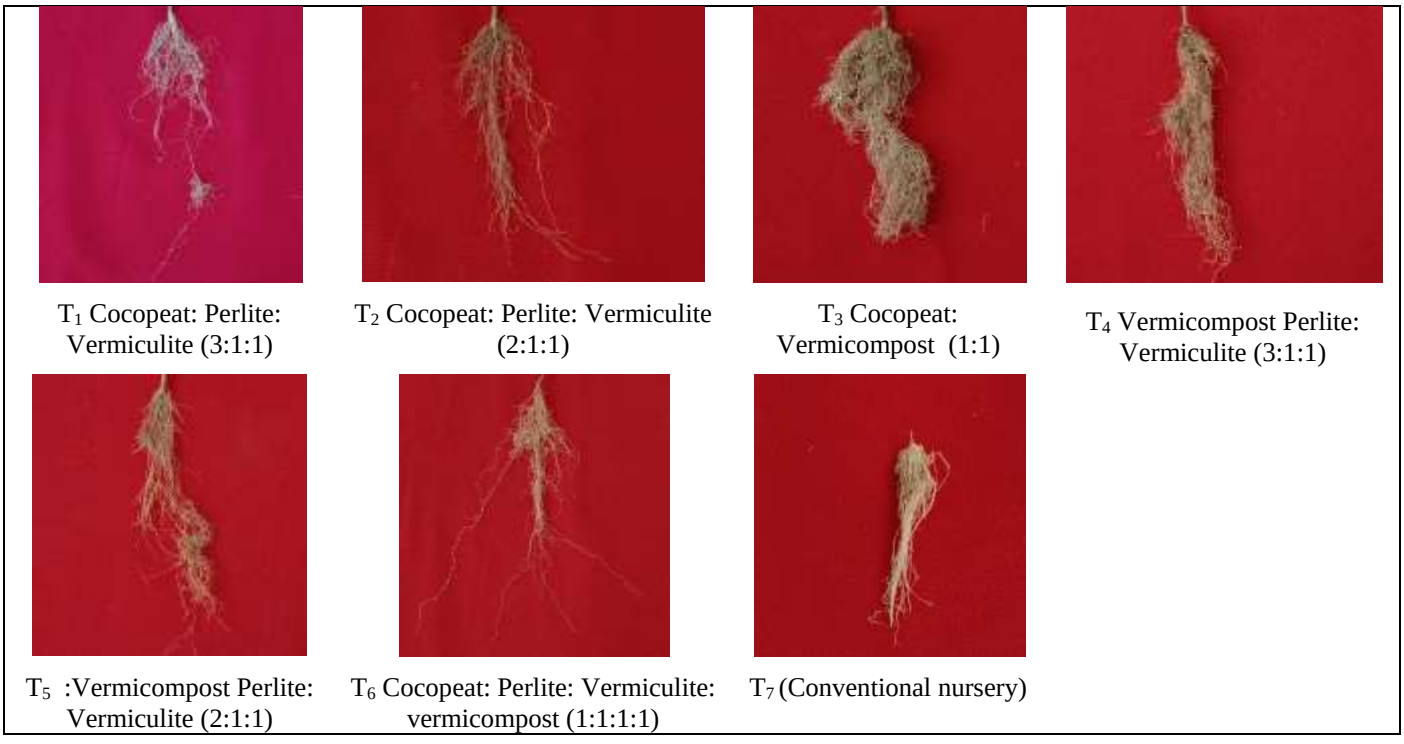

Fig 4: Fresh root of broccoli seedling under different sowing media

Conclusion

The findings of this investigation showed that conventional greenhouse seedling raising of broccoli in sowing media T_3 [(Cocopeat: Vermicompost (1:1) and sowing media T_6 [Cocopeat: Vermicompost: Perlite: Vermiculite (1:1:1:1)] is more effective than raising seedlings in the traditional open field i.e.T_7 (Conventional nursery).

These media have a significant potential to produce broccoli seedlings that are robust and healthy, which ultimately leads to improved performance in the main field after transplanting in terms of yield and yield attributing characters.

Acknowledgement

Acknowledgements We gratefully acknowledge the College of Agriculture, Assam Agricultural University, Jorhat, Assam, India for the research and financial and other facilities and to the Horticulture Research Station, Ktrain, Himachal Pradesh and Daffodils Nursery, Guwahati, Assam providing me seeds and and seed owing material to carry out this experiment successfully.

Reference

1. Abirami KJ, Rema PA, Mathew PV, Srinivasan V, Hamza S. Effect of different propagation media on seed germination, seedling growth and vigour of nutmeg (*Myristica fragrans* Houtt.). J Med. Pl. Res. 2010;4:2054-2058.
2. Alex VA, Krishnaswamy V, Jerkin R, Natarajan S. Elite seedling production in tomato cv. PKM 1 using organic nursery. South Ind. Hort. 2007;55(1-6):216-219.
3. Bachman GR, Metzger JD. Growth of bedding plants in commercial potting substrate amended with Vermicompost. Biores. Tech. 2008;99:3155-3161.
4. Bhardwaj RL. Effect of growing media on seed germination and seedling growth of Papaya cv. Red lady. Ind. J. Agric. Res. 2013;47(2):163-168.
5. Bilderback TE, Warren SL, Owen Jr JS, Albano JP. Healthy substrates need physicals too! Hort. Tec. 2005;15:747-757.
6. Chatterjee R, Choudhuri P. Influence of vermicompost as potting mixture on growth of Moringa (*Moringa oleifera* Lam.) seeding under Terai Zone of West Bengal. National Workshop on 'Oragnic Hortic.' Held at Bidhan Chandra Viswavidyalaya, Mohanpur, West Bengal, India, 8-10 June 2007. 2007.
7. Chopde N, Patil B, Paggar PC, Gawande R. Effect of different pot mixture on germination and growth of custard apple (*Annona squamosa* L.). J Soils crops. 1999;9(1):69-71.
8. Hazarika M, Saikia J, Phookan DB, Kumar P, Gujar K. Effect of different growing media on seedling quality and field performance of Cabbage (*Brassica oleracea* var. capitata L.). The Pharma Innov. J. 2022;11(1):1493-1497.
9. Mota LC, Van Meeteren UV, Blok C. Comparison of physical properties of vermicompost from paper mill sludge and green compost as substitutes for peat based potting media. Acta Hort. 2009;819:227-234.
10. Panse VS, Sukhatme PV. Statistical Method for agricultural Workers. Publication and information Divison, ICAR. New Delhi; c1978.
11. Parasana JS, Leua HN, Ray NR. Effect of different growing media mixtures on germination and seedling growth of mango (Mangifera indica L.) cultivars under net house condition. The Bioscan. 2013;8(3):897-900.
12. Patel MV, Patmar BR, Halpati AP, Parmar AB, Pandey AK. Effect of growing media and foliar spray of oragnics on seedling growth and vigour of acid lime. Int. J. Chem. Stud. 2019;7(1):01-04.
13. Prajapati DG, Satodiya BN, Desai AB, Nagar PK. Influence of storage period and growing media and seed germination and growth of acid lime seedling (*Citrus aurantifolia* swingle) cv. Kagzi. J. Pharmacognosy and Phytochem. 2017;6(4):1641-1645
14. Rana MK. Olericulture in India. Kalyani publisher in India, New Delhi; c2008. p. 301.
15. Sarvanan TS, Rajendran K, Santhaguru K. Selection of suitable bio-fertlizer for production of quality seedling of Casurina equisetifolia using decomposed coir pith compost in Root Trainers. Asian J. Expt. Biol. Sci. 2012;3(4):752-761.
16. Shani S, Sarma BK, Singh DP, Singh H, Singh KP. Vermicompost enhance performance of plant growth promoting rhizobacteria in Cicer arietinum rhizosphere against. Sclerotium rolfsii. Crop protection. 2008;27:369-376.
17. Singh B, Yadav HL, MNPS, Sirohi M. Effect of plastic plug tray cell size shape on quality of soilless media grown tomato seedling. Acta. hort. 2007;742:57-60
18. Subbaiah KV, Reddy RVSK, JD, Raju GS, Karunasree E, Reddy AD, *et al*. Effect of different level arka microbial constrium on seed germination and survival rate in brinjal cv. Dommeru Local. Int. J Curr. Microbial. App. Sci. 2018b;7(6):2821-2825.
19. Vaughn SF, Deppe NA, Palmquist DE, Berhow MA. Extracted sweet corn tassels as a renewable alternative to peat in greenhouse substrates. Industrial Crops and Products. 2011;33:514-517.
20. Wilson RI, Kunos G, Nicoll RA. Presynaptic specificity of endocannabinoid signaling in the hippocampus. Neuron. 2001 Aug 16;31(3):453-62.
21. Baiyeri KP, Mbah BN. Effects of soilless and soil-based nursery media on seedling emergence, growth and response to water stress of African breadfruit (Treculia africana Decne). African Journal of Biotechnology. 2006;5(15).
22. Atiyeh RM, Edwards CA, Subler S, Metzger JD. Pig manure vermicompost as a component of a horticultural bedding plant medium: effects on physicochemical properties and plant growth. Bioresource technology. 2001 May 1;78(1):11-20.
23. Nissi E, Sarra A. A measure of well-being across the Italian urban areas: An integrated DEA-entropy approach. Social Indicators Research. 2018 Apr;136:1183-209.
24. Borah M, Owens RM, Irwin MJ. An edge-based heuristic for Steiner routing. IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems. 1994 Dec;13(12):1563-1568.
25. Uezu A, Metzger JP, Vielliard JM. Effects of structural and functional connectivity and patch size on the abundance of seven Atlantic Forest bird species. Biological conservation. 2005 Jun 1;123(4):507-519.
26. Younis M, Youssef M, Arisha K. Energy-aware management for cluster-based sensor networks. Computer networks. 2003 Dec 5;43(5):649-668.
27. Habs D, Kester O, Rudolph K, Thirolf P, Hinderer G, Raimbault-Hartmann H *et al*. The Rex-ISOLDE Project. Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms. 1997 Apr 4;126(1-4):218-223.