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Evaluation of Cocopeat-Based Substrate Combinations for Enhancing Growth, Yield and Fruit Quality of Brinjal (*Solanum melongena* L.) under Soilless Cultivation

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Abstract

Brinjal (*Solanum melongena* L.) is an important vegetable crop widely cultivated in Asia, with India being one of the leading producers. However, increasing population pressure, climate change, and limited land availability have highlighted the need for alternative cultivation methods such as soilless culture. Cocopeat, a by-product of the coconut industry, is widely used as a growing medium due to its high moisture retention and favorable physicochemical properties, though it is not suitable when used alone. The present study aimed to evaluate the effect of cocopeat-based substrates on the growth, yield, and quality of brinjal. Two treatments were tested: T1 (cocopeat + neem powder) and T2 (cocopeat + farmyard manure + neem powder). The experiment was conducted in plastic containers under open conditions. Growth parameters such as plant height, number of leaves, and yield attributes were recorded. Results indicated that the combination of cocopeat with farmyard manure (T2) significantly improved plant growth, yield, and quality compared to cocopeat alone (T1). The study concludes that enriching cocopeat with organic manure enhances its suitability as a growing medium for brinjal cultivation under soilless conditions.

Keywords: Coco peat, Neem powder, Farm yard manure, Brinjal, Coconut etc.

Introduction

Brinjal (*Solanum melongena* L.), commonly known as eggplant or aubergine, is an important solanaceous vegetable crop cultivated for its edible fruit. It is the second most important solanaceous vegetable after tomato in the genus *Solanum* [1]. The crop is widely grown in tropical and subtropical regions including India, China, Bangladesh, Pakistan, and the Philippines, and is also popular in Mediterranean countries and the United States [2]. In India, brinjal is one of the most common and widely cultivated vegetable crops, grown across diverse agro-climatic regions except at higher altitudes. Although botanically perennial, it is commercially cultivated as an annual crop. Numerous cultivars are grown across the country with considerable variation in fruit size, shape, and color depending on consumer preference [3]. Brinjal has been cultivated in India for more than 4000 years and plays a significant role in vegetable production and food security [2]. Globally, eggplant is cultivated on approximately 1.9 million hectares with an annual production exceeding 60 million tonnes. China is the largest producer, followed by India. In India, brinjal is grown on nearly 0.68 million hectares with a production of around 12.8 million tonnes, contributing substantially to the total vegetable production of the country [4]. Major brinjal-producing states include West Bengal, Odisha, Bihar, Gujarat, Maharashtra, Karnataka, Uttar Pradesh, and Andhra Pradesh. Brinjal is a warm-season crop and performs best under a long and warm growing season. The crop is highly sensitive to frost and low temperatures, which may lead to poor fruit set and deformation. An optimum temperature range of 13–21°C is favorable for growth and yield, while seed germination occurs best at around 25°C [5].

The crop can be grown in a wide range of soils from sandy loam to clay loam, provided the soil is well-drained and rich in organic matter with a pH range of 6.5–7.5 [6].

Brinjal is nutritionally important due to the presence of essential minerals such as potassium, calcium, sodium, and iron [7]. The fruit contains about 92.7% water, 4% carbohydrates, 1.4% protein, 1.3% fiber, and 0.3% fat, along with small quantities of vitamins and minerals [8]. The fruits also contain polyunsaturated fatty acids such as linoleic and linolenic acids, which are associated with cholesterol-reducing properties. Due to its medicinal value, brinjal has been used in traditional medicine for the treatment of liver disorders, allergies, rheumatism, and digestive problems [9].

Despite its importance, conventional soil-based agriculture is facing several challenges, including declining per-capita land availability, soil degradation, urbanization, industrialization, and climate change. These challenges are expected to intensify in the future, making it increasingly difficult to meet the food demand of a growing population using traditional soil cultivation systems. Under such circumstances, soilless cultivation systems are gaining attention as a sustainable alternative for crop production [10]. Soilless culture involves growing plants in various organic or inorganic substrates without the use of natural soil. This technology offers several advantages, including improved water and nutrient use efficiency, higher yields, better crop quality, and reduced incidence of soil-borne diseases [11].

Coconut (*Cocos nucifera* L.) is one of the most important plantation crops in tropical regions of the world. According to FAOSTAT, coconut is cultivated in more than 90 countries with global production exceeding 60 million tonnes annually [4]. India is one of the leading coconut-producing countries, with a cultivation area of about 2.18 million hectares and production exceeding 21 billion nuts annually [12]. One of the major by-products of coconut processing is coir pith (cocopeat), obtained from coconut husk during fiber extraction. India generates nearly 7.5 million tonnes of coir pith annually, which often accumulates as agricultural waste and creates environmental concerns [13].

Coir pith has gained considerable importance as a growing medium in horticulture due to its favorable physical and chemical properties. It possesses high water holding capacity, good aeration, and high cation exchange capacity, making it suitable for plant growth [14]. However, the direct use of cocopeat alone in agriculture is limited because of its high lignin content and wide carbon-to-nitrogen ratio, which slows down decomposition. Therefore, cocopeat is often combined with organic manures such as farmyard manure, vermicompost, or neem powder to improve its nutrient availability and biological properties [15]. Such combinations can serve as effective substitutes for soil in modern soilless cultivation systems.

Considering the growing demand for sustainable agricultural practices and efficient utilization of agricultural waste, the use of cocopeat as a substrate in soilless cultivation offers a promising opportunity. Therefore, the present study was undertaken to evaluate the effect of cocopeat-based substrate combinations on the growth, yield, and quality of brinjal under protected cultivation (Verhagen, 2009).

Site

The present investigation was conducted at the Research Farm, Department of Agricultural Engineering, Aditya University, Surampalem, East Godavari district. Geographically Surampalem is situated at 6 meter above mean sea level. The average temperature in Surampalem was 27.7 °C and although it is very warming in May with maximum temperature of 39°C. The mean annual rainfall is around 1161mm per year. More than half of the annual rainfall brought by south west monsoon while the large portion of thirst received during the north east monsoon period. The humidity is 58% and the wind blows with a velocity of 3.1 m/s from the south east direction.



Fig 1: Constructional view of the experimental green house

Coco peat

Coconut palm is an important plantation crop grown in 1.89 million ha in India supporting livelihood of many Indians (Tiwarei, 2015). Cocopeat is basically coir dust, a by-product from the coir industry. Cocopeat is a multipurpose growing medium out of coconut husk. Coconut fiber is granulated or crushed and then sieved to a certain particle size to obtain the cocopeat. It is hundred percentage organic and eco-friendly. Cocopeat is used for horticulture and agricultural applications. From the nearest coconut coir industry, the required amount of cocopeat which is not composted was collected for the present study.

Table 1: Physiochemical characters of coco peat and compost coco peat

Parameters	Raw cocopeat	Composted cocopeat
Lignin (%)	30.00	4.80
Cellulose (%)	26.52	10.10
Organic carbon (%)	26.00	24.00
Nitrogen (mg/kg)	0.26	1.24
Phosphorus (mg/kg)	0.01	0.06
Potassium (mg/kg)	0.78	1.20
Calcium (mg/kg)	0.40	0.50
Magnesium (mg/kg)	0.36	0.48
Iron (ppm)	0.07	0.09
Manganese (ppm)	12.50	25.00
Zinc (ppm)	7.50	15.80
Copper (ppm)	3.10	6.20
C:N ratio	112:1	24:1
Water holding capacity (%)	450.38	481.61

Methodology



Fig 2: Sieving the granulated coir



Fig 3: Mixing Neem Powder with Cocopeat

Neem powder

The neem seed kernels are pressed through expeller to obtain a neem seed oil and a by-product obtained at the end of this process in the form of cake is known as Neem powder which can be used as natural fertilizer provides antimicrobial property which helps in reducing fungal growth and root borne diseases.

A pure neem powder bag of 25 kg was bought from the Gromour shop which is located in Peddapuram, East Godavari district, Andhra Pradesh.

Farm Yard Manure

Farm Yard Manure (FYM) refers to the decomposed mixture of dung and urine of farm animals along with litter and left over material from fodder fed to the animals. The FYM prepared in the farm shed at Aditya University was collected in the required amount for the present study.



Fig 4: Removing the foreign matter from farm yard manure

Seedlings

A poly bag is a type of container made of thin, flexible, plastic film, nonwoven fabric or plastic textile. These require less energy to produce than hard containers and they are also recyclable. Polyethylene nursery bags also conserve

water by retaining moisture in the soil growing media (cocopeat substrate) longer than other type of plant containers. Poly bags of black colour with holes punched on them for proper drainage and oxygen flow to the plants being grown in them were bought from the nursery in Kadiyam near to the Rajahmundry. These are having size of 19×18×30cm (L×W×H).

A Green net or shade net is generally a synthetic fiber net made up of HDPE plastic, which reduces the intensity of direct sunlight according to the necessity of crops or others. Shade nets are used to protect agro products such as plants, vegetables, fruits, and flowers from birds, insects, weather, etc. This shade net is available in densities ranging from 30% to 90% to suit the unique needs of different types of plants, flowers and crops (For example, if the density of the shade net is said to be 40% that means it will cut off 40% of light intensity and allows the 60% of light intensity through it into the green house). Seedlings of Brinjal variety were collected from the nursery of Kadiyam where the seedlings are germinated in a cocopeat mixture.

Experimental Procedure

Coco peat is also known as coir pith, made from coconut husk which are byproducts of coir industry. Coir waste from coir industry is processed into coco peat, which is then used for horticultural and agricultural application. Coco peat in combination with Farm Yard Manure, and Neem powder formed suitable media for soil substitute. The experiment was performed in various stages in poly bags covered with agronet in open condition. The two treatments were:

T1- Coco peat alone + Neem powder (9:1),

T2- Coco peat + Farm Yard Manure + Neem Powder (6:3:1).

Preparation of growing media mixture

Coir waste, in the form of granulated or crushed coconut fiber obtained from coconut husk, was collected from the nearest coir industry. The collected material was processed by sieving to obtain a uniform particle size, ensuring consistency in the growing media.

For Treatment 1 (T1), the processed cocopeat was mixed with neem powder in a ratio of 9:1 (w/w). Specifically, nine kilograms of cocopeat were thoroughly blended with one kilogram of neem powder to prepare the growing medium. The mixture was prepared in sufficient quantity to fill a total of fifty polybags. For Treatment 2 (T2), the growing medium was prepared by mixing cocopeat, farmyard manure, and neem powder in a ratio of 6:3:1 (w/w). In this formulation, six kilograms of cocopeat were combined with three kilograms of farmyard manure and one kilogram of neem powder. The components were mixed uniformly to ensure homogeneity. The prepared medium was produced in adequate quantity to fill fifty polybags.

Transplanting & Irrigation

A fully germinated seedlings of brinjal are bought from the nearest nursery in which seedlings are germinated in cocopeat substrate only. Now the collected brinjal seedlings are replanted at 2 inches depth in 100 poly bags of two different treatment mixtures. Two seedlings are planted per each poly bag. According to Basavarajappah. Bhogi, the total water requirement of brinjal from planting to harvesting was found to be 41.943 litres per plant, 55.894 litres per plant, 69.916 liters per plant and 83.858 liters per

plant under drip irrigation levels of 60, 80, 100 and 120 per cent crop ET, respectively and it was 86.30 liters per plant in case of furrow irrigation system (Karnataka, J.Agric, 2010). But, in the present study instead of water giving through drip and furrow methods, watering in a normal way

with rose cans of capacity 10 litres. Immediately after transplanting, small amount of water was given per each bag and continued for 3 days. Thereafter, daily 8 rose cans of water took per 200 plants that means on average 0.4 litres of water per each plant is given daily upto harvesting.



Fig 5: Transplanting and Irrigation Requirements

Results and Discussion

Pre & Post Harvest Observations

The height was measured after 15 days from transplanting and followed with that interval. The maximum height (i.e., 74.8 cm) of the plant was recorded in treatment-2 (cocopeat + farm yard manure + neem powder in the ratio 6:3:1) than that in the treatment -1 (cocopeat + neem powder in the ratio 9:1). This might be attributed to farm yard manure contains 33 per cent nitrogen form causing its immediate and efficient utilization for better growth and development and improvement in plant growth. With 15 days interval from transplanting, the no. of leaves counted for five observational plants separately for two treatments and average was recorded as shown in the Fig. 8. The maximum no. of leaves per plant was recorded in treatment-2 (cocopeat + farm yard manure + neem powder in the ratio 6:3:1) than

that in the treatment-1 (cocopeat + neem powder in the ratio 9:1). This might be attributed to the release of nitrogen from farm yard manure in comparison to other nutrient sources, efficient utilized for better growth. The five randomly picked brinjals in two treatments are weighed separately. It was observed that average weight of the fruit in T-2 (cocopeat + FYM + neem powder) is 89.4g which is higher than the average fruit weight of 32.2g in T-1 (cocopeat + neem powder). This might be obtained due to the release of more nitrogen through the FYM in T-2. By using the vernier callipers the length of five observational brinjals was measured and average was worked out for both treatments. In T-1, the length (6.4 cm) of the fruit was recorded which is less than the fruit length (7.8 cm) observed in the T-2 which could be due to absence of FYM in T-1 leads to low amount of nitrogen release which may affect the fruit length.

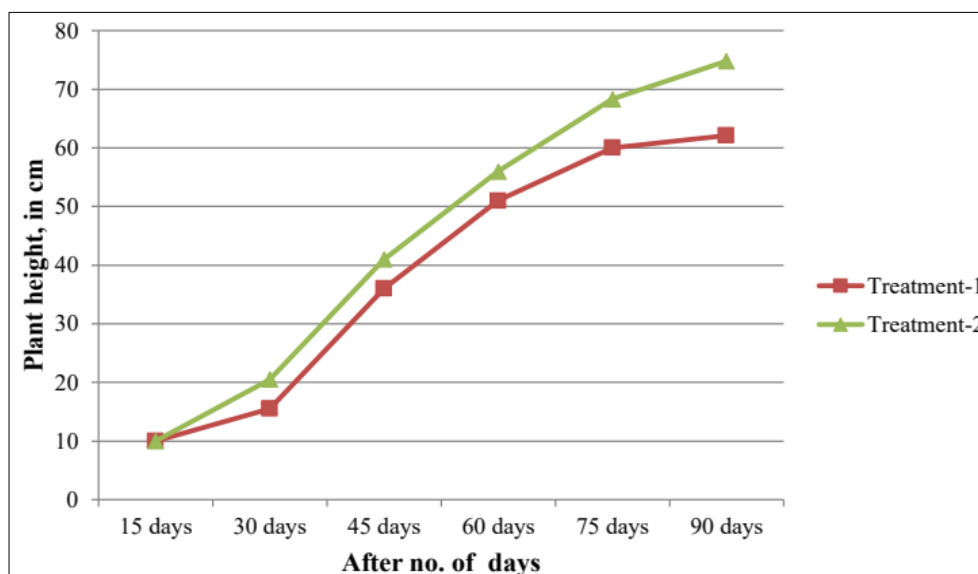


Fig 6: Plant height (cm) of brinjal as influenced by two different growing media

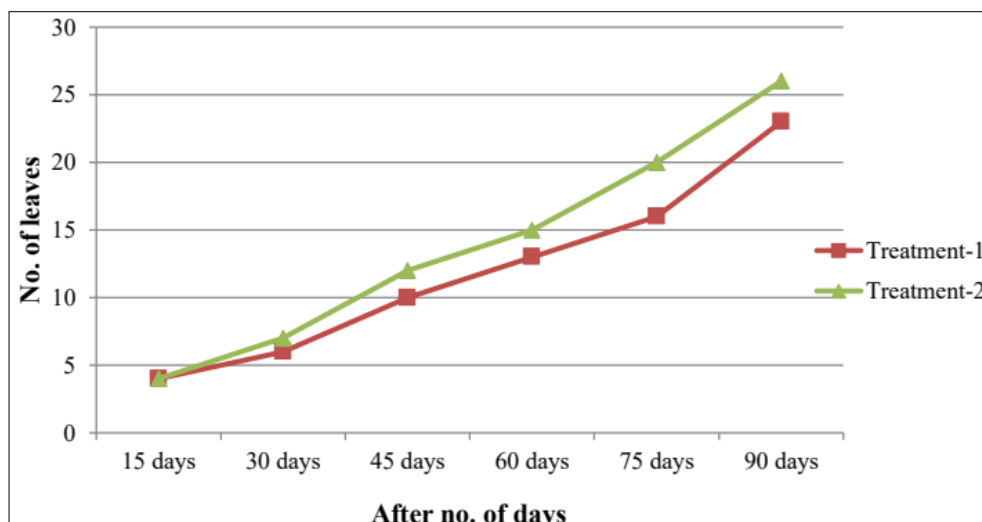


Fig 7: No. of leaves plant as influenced by two different growing media

The significant differences were observed in fruit diameter of different treatments. The maximum fruit diameter (6.47cm) was recorded in treatment cocopeat + FYM + neem powder (T2) while the minimum diameter of fruit (3.76 cm) was recorded in treatment cocopeat + neem powder (T1). The maximum diameter of root in the

treatment (T2) might be due to the contribution to the balanced C: N ratio and enhanced availability of essential plant nutrients hence increased rate and efficiency of metabolic activities resulting in increasing cell division, high assimilation of protein and carbohydrates.

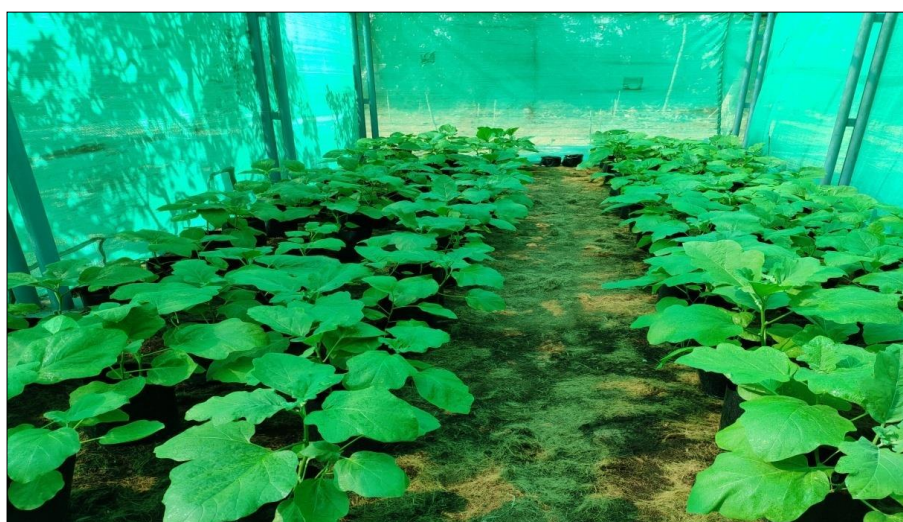


Fig 8: Stage of first flowering

Yield parameters

The harvesting is done at three times with an interval of ten days from the fruit maturity date. At each time of harvesting the number of fruits for five observational plants were counted and average was computed which was given in Fig. 9. It is clear from Fig. 10, that the maximum no. of fruits per plant (34) was observed in treatment cocopeat + FYM + neem powder (T-2) while the minimum no. of fruits per plant (13) was observed in the treatment cocopeat + neem powder (T-1). The brinjals harvested from the five observational plants are weighed at each picking and the average weight of fruits per plant was calculated which are presented Fig. 10. It is from the observations made that the highest yield per plant (3.78 kg) was recorded in the treatment cocopeat + FYM + neem powder (T-2) than the

yield per plant (0.64 kg) in the treatment cocopeat + neem powder (T-1). This might be due to nutrient sources which helps in growth such as nitrogen, organic carbon, potassium, phosphorus, zinc, copper, etc., are present in the required amount in T-2 while in the T-1, the presence of lignin (30%) and cellulose (26.52%) which affects the growth of fruits. Data regarding scores obtained after evaluation of brinjal plants of different treatments for Organoleptic test regarding different quality parameters like appearance, colour, size and weight, shoot as vegetable, pungency and average rating.

The scoring was done for each character out of 5 marks, in which five score was given for excellent, four for better, three for good, two for average and one for poor and average ratings were converted to 5 points scale.

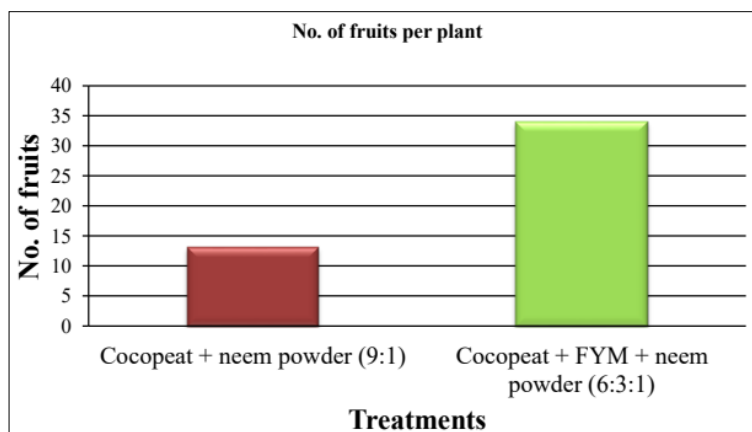


Fig 9: Fruits per plant influenced by different media

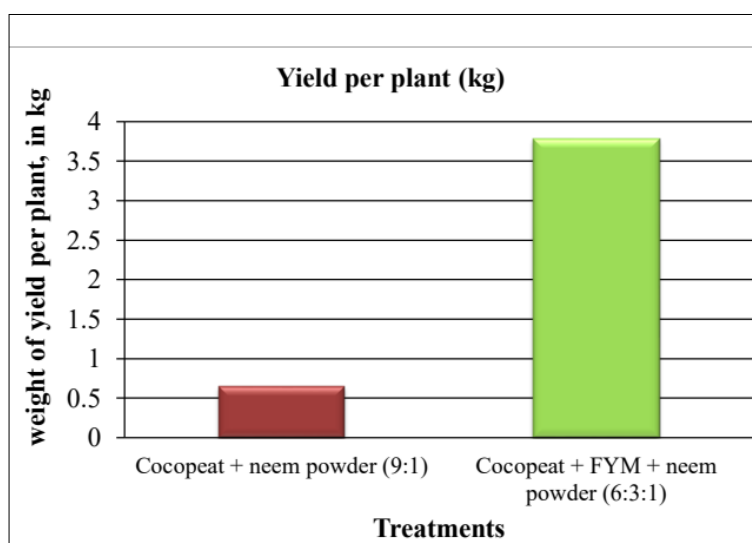


Fig 10: Yield per plant influenced by different media

The maximum score (4.86) was obtained in treatment of cocopeat + FYM + Neem powder (T-2) in the ratio 6:3:1. While the lowest score (3.19) was observed in treatment of cocopeat + neem powder (T-1) in the ratio 9:1. The high score for colour character ranged 3.91 in T-2 than the score

(2.69) observed in T-1. Regarding the size and weight character the score was ranged 4.78 which is the maximum value obtained in T-2. The values for pungency character ranged 4.34. The maximum value was obtained by T-2 while, the lowest value was observed in treatment T-1.

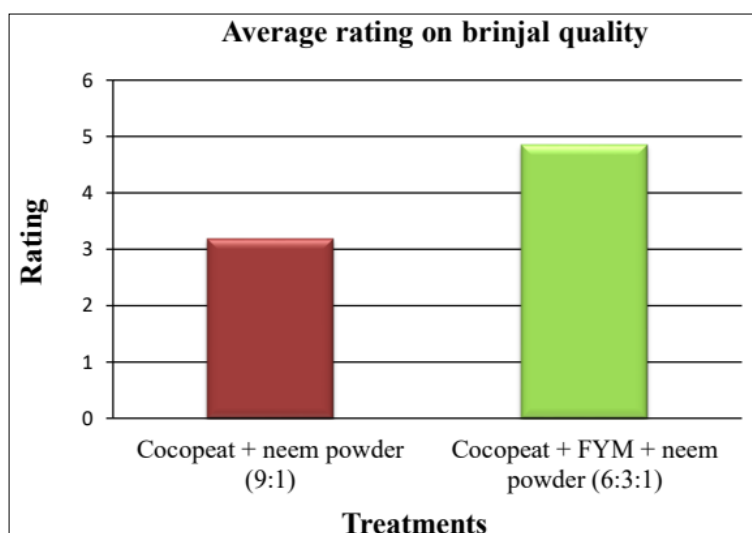


Fig 11: Organoleptic test of Brinjal influenced by different media

Conclusions

The present study demonstrated that the composition of cocopeat-based growing media significantly influences the growth, yield, and quality parameters of brinjal. Among the treatments, cocopeat combined with farmyard manure (FYM) and neem powder in the ratio of 6:3:1 (T2) consistently produced superior results, recording maximum plant height (74.8 cm), number of leaves per plant (26), fruit weight (89.4 g), fruit length (7.8 cm), and fruit diameter (6.47 cm). In contrast, the treatment with cocopeat and neem powder alone in the ratio of 9:1 (T1) showed comparatively lower performance across all parameters.

Organoleptic evaluation also supported these findings, with T2 achieving the highest average score (4.86), while T1 recorded the lowest (3.19). The improved performance of T2 can be attributed to the enhanced availability of macro (N, P, K) and micro (Mg, Ca) nutrients, along with better physicochemical properties provided by the addition of FYM. Overall, the study concludes that cocopeat alone is not sufficient as a growing medium; however, its combination with farmyard manure significantly enhances plant growth, yield, and quality, making it a more suitable substrate for vegetable cultivation.

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