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RESEARCH ARTICLE

COMPARATIVE STUDY BETWEEN PEAT MOSS AND PEANUT SHELL AS A NURSERY MEDIA

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ABSTRACT

Nursery management practices play a crucial role in the growth and development of plants cultivated within nurseries. This experimental study has been laid out during 2022 and 2023 growing seasons and aimed to investigate the influence of some nursery substrates mixture management on seedlings growth and development. Peanut (Arachis hypogaea) shell has gained attention for their versatility and potential application in complete nurseries. The study aimed to explore the feasibility of using grounded peanut shell, as an affordable organic nursery substrate for cultivating seedlings of beans, cucumber, tomatoes, cantaloupe, zucchini, cabbage and lettuce. Different mixtures of grounded peanut shell 0, 25, 50, 75 and 100% (v/v), as an alternative of peat moss mixed with in a randomized complete block design (RCBD) in three replicates. Several parameters were assessed. The study evaluates several parameters of seedling growth, such as seedling dry weight, seedling fresh weight, seedling stem diameter, seedling length, seedling leaf area, number of leaves, and the nutrient content (NPK) of the seedling leaves. The results indicate that the most favorable treatment is a mixture of 50% traditional nursery substrate and 50% peanut shell (T3). This combination yielded the best outcomes across the evaluated parameters and economic value. The study illustrated the promising role of peanut shell in promoting seedling growth and development for the specified crops.

KEYWORDS

Grounded peanut shell, peat moss, seedlings, beans, cucumber, tomatoes, cantaloupe, zucchini, cabbage and lettuce.

1. INTRODUCTION

A nursery is considered a place where plants are well managed during the early stages of growth, providing optimum conditions for germination and subsequent growth until they are strong enough to be transplanted into the permanent field (Smith et al., 2020). Nursery management practices exert a profound impact on plant growth and development. Through carefulness implementation of irrigation, fertilization and pest control strategies, nurseries can improve plant health, increase yield and maintain profitability. Continued research and adoption of best management practices are essential for ensuring the sustainability and success of nursery operations (Fernandez and Fitzpatrick, 2006). Waste reduction, and energy conservation initiatives should be adopted by nurseries to minimize environmental impacts. Sustainable nursery practices had important role in reducing resource consumption, mitigating pollution, and promoting ecosystem health (Wang and Li, 2018). Researchers have been highlighted the potential techniques to enhance nursery productivity and sustainability while meeting the growing demand for high-quality plants (Kessler and Paradi, 2019). Peat materials are common media in nurseries around the world, comprehensively examines recent advancements in nursery mediums for sustainable vegetable seedling production (Smith et al., 2020). There are many innovations in peat-free nursery mediums uses for organic vegetable production. In this concern, the performance of many alternative mediums have been assessed including peanut shell, rice husk, and wood fiber, in supporting the growth of vegetable seedlings. Research emphasizes the need to reduce reliance on peat-based mediums due to environmental concerns (Chang and Chen, 2021). Many studies had discussed various organic and synthetic mediums, their properties and their impact on seedlings growth and health. Some of research studies investigated the efficacy of using peanut shell as a nursery medium for tomato seedlings and demonstrated its promising potential in supporting the growth and development of tomato seedlings as a sustainable alternative to conventional nursery substrates (Garcia *et al*., 2022). Researchers examined the nutritional composition of peanuts, highlighting their rich content of essential nutrients and potential health benefits (Awad et al., 2017). Peanut plant enhanced soil fertility and supported subsequent crop productivity within nursery settings, emphasizing their nitrogen-fixing capabilities (Nguepjop et al., 2017). Utilization of peanut shell as a substrate for cucumber seedling production has been studied, Peanut shell substrate promoted favorable root development and enhanced seedling vigor, indicating its potential as an effective nursery medium (Chen *et al*., 2021). Peanut is a globally significant crop, prized for its nutritious seeds. While the edible portion of peanuts takes attention, the byproduct - peanut shell - often goes overlooked. However, recent scientific endeavors have shed light on the multifaceted nature of peanut shell, revealing their rich composition and versatile applications (Li et al., 2020).

This study aimed to evaluate the effect of partially substituting peat moss with grounded peanut shell on seeds germination and the quality of some vegetable seedlings.

2. MATERIAL AND METHODS

This study was conducted in a semi-controlled glasshouse at the experimental site of the Central Laboratory for Agricultural Climate

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(CLAC) in Dokki, Giza, Egypt, during the 2022 and 2023 growing seasons. The aim was to study the possibility of replacing peat moss in traditional nursery media with grounded peanut shell in different percentages for producing some vegetable seedlings.

2.1 Experimental material

2.1.1 Vegetable seeds

Seeds of beans (*Phaseolus vulgaris*), cucumber (*Cucumis sativus*), tomato (*Lycopersicon esculentum*), cantaloupe (*C.melo var. cantalupensis*), zucchini (*Cucurbita pepo*), cabbage (*Brassica oleracea var. capitata*) and lettuce (*Lactuca sativa*) were sown in foam trays. Standard seedlings trays (84 and 209 eyes depending each standard crop requirement) were used and filled with different substrate mixtures. After sowing the different crops seeds, the trays were arranged on the tables under glasshouse conditions. The sowing dates of different vegetable crops were differed based on the variation of crops. The sowing dates and the number of days from sowing to seedling for each crop are shown in Table (1).

Table 1: Sowing dates and days after sowing for each crop.

Crop name	Sowing date	Number of days from sowing to seedling
Bean	1/10/2022 and 1/10/2023	25
Cucumber, cantaloupe, zucchini	3/10/2022 and 3/10/2023	30
Tomato	15/11/2022 and 15/11/2023	45
Cabbage	1/12/2022 and 1/12/2023	45
Lettuce	15/10/2022 and 15/10/2023	30

2.1.2 Traditional media

This media was contained peat moss and vermiculite 1:1 (v/v). Mineral fertilizers were added to 600 L of this mixture. These fertilizers were ammonium sulphate (250-300g), potassium sulphate (300-400g), calcium super phosphate (200-250g) and mixture of micronutrients Fe, Zn and Mn (50-70g). The media also included chemical fungicides (Penlight, Vetafax, Kapetan, Rizolex 50g) and calcium carbonate (4 Kg) to modifying the PH of media (Extension bulletin, 1993), Ministry of Agriculture and Land Reclamation).

2.1.3 Peanut shell media

It was the same content of the traditional media except replacing the peat moss with grounded peanut shell. There were two different types of machines used for grinding peanut shells. The first machine was designed to chop peanut shells to size between 1 to 0.5 cm and its capacity was one ton per hour. The second machine was equipped with a hammer mill drum and fixed knife, capable of reducing peanut shell sizes from 1 to 0.5 cm down to about 2 mm. The ground peanut shell was then resized using two sieves, with openings of 1 mm and 2 mm.

2.2 Experimental treatments

The treatments were five mixture of these two media in different percentages as follow:

- Traditional media peat moss and vermiculite 1:1 (v/v) 100% (T1)
- Media mixture of 75% peat moss + 25% grounded peanut shell (T2)
- Media mixture of 50% peat moss + 50% grounded peanut shell (T3)
- Media mixture of 25% peat moss + 75% grounded peanut shell (T4)
- Media mixture of 0% peat moss + 100% grounded peanut shell (T5)

The main physical and chemical properties of the different treatments under the current investigation, are shown in Table (2).

Table 2: Physical and chemical properties of different mixtures, of peanut shell and peat moss nursery media.

Treatment / Component/Property	T1	T2	T3	T4	T5
Water Holding Capacity %	70	55	50	30	10
Bulk Density g/cm³	0.2	0.2	0.25	0.3	0.3
Total Porosity %	85	78	67	56	40
pH	4.5	5	5.5	6	6.5
EC mS/cm	0.32	0.5	0.6	0.7	0.7
Organic Matter Content %	85	85	82	82	75
N %	0.5	2	2	2.5	2.5
P %	0.2	0.15	0.15	0.1	0.5
K %	0.3	0.2	0.3	0.4	0.4
Ca %	0.5	0.4	0.5	0.5	0.4
Mg %	0.2	0.1	0.2	0.2	0.2
C:N Ratio	20/1	32/1	25/1	34/1	40/1

T1: peat moss and vermiculite 1:1 (v/v), T2: 75% peat moss + 25% peanut shell, T3: 50% peat moss + 50% peanut shell, T4: 25% peat moss + 75% peanut shell and T5: 0% peat moss + 100% peanut shell

T1: peat moss and vermiculite 1:1 (v/v), T2: 75% peat moss + 25% peanut shell, T3: 50% peat moss + 50% peanut shell, T4: 25% peat moss + 75% peanut shell and T5: 0% peat moss + 100% peanut shell

2.3 Recorded data

2.3.1 The physical and chemical properties of substrates

Table (2) illustrated the physical and chemical properties of different substrates as follows: Bulk density (B.D), total porosity (T.P) and water hold capacity % (W.H.C) were estimated regarding to **(Abul-Soud *et al.*, 2017)**. The PH of the potting mixtures was determined by preparing a suspension of each mixture in double distilled water at a ratio of 1:10 (w), following the method described by (**Inbar *et al.* 1993).** The suspensions were mechanically agitated for 2 hours and then filtered through Whatman no.1 filter paper. The same solution was used to measure electrical conductivity (EC, in mMhos/cm) using a conductance meter that had been calibrated with 0.01 and 0.1M KCl solutions.

2.3.2 Vegetative measurements

Seed germination percentages of different studied crops (beans, cucumber, tomatoes, cantaloupe, zucchini, cabbage and lettuce) were determined as well as seedling period. Twelve seedlings from each tray of different studied vegetable crops were collected, and the following characteristics were measured for each seedling: dry weight, fresh weight, stem diameter, length of seedling, leaf area, and number of leaves.

2.3.3 Chemical analysis

Here's how each parameter was determined:

Dry Weight (g): Seedling leaves and shoots were dried at 70°C until a constant weight was achieved. The dry weight per plant was then calculated.

- Total Nitrogen (% N**)**: Total nitrogen content in the leaves was determined using the micro Kjeldahl method, following the procedure outlined in (A.O.A.C., 1991).
- Phosphorus (% P): Phosphorus content was determined calorimetrically at 550 nm, as described by (Ranganna, 1979).
- Potassium (% K): Potassium content was determined using a flame photometer, following the method described by (Ranganna, 1979).

These methods are standard procedures commonly used in agricultural and biological research to assess nutrient content and plant characteristics accurately.

2.3.4 Statistical analysis

The experiment was organized using a randomized complete block design (RCBD) with three replicates and five treatments. Each treatment, representing different seedling media, was randomly assigned within each replicate for each crop studied. Data from both seasons were combined and statistically analyzed using analysis of variance (ANOVA), following the methods outlined by (Snedecor and Cochran, 1980). Statistical analysis was conducted using SAS software, version 2004.To determine significant differences between treatment means, Duncan's test was employed at a significance level of 0.05. Duncan's test is a multiple comparison procedure that helps identify which treatment means are significantly different from each other. This approach allows for robust conclusions about the effects of different seedling media on the growth parameters and nutrient content of the seedlings across the studied crops.

3. Results

Based on Table (3), the effect of peat moss and peanut shell media on seed germination percentage was evaluated across various crops including beans, cucumber, tomatoes, cantaloupe, zucchini, cabbage and lettuce. Remarkably, the germination of all these crops remained unaffected by the mixture of peanut shell media. However, a consistent observation was made regarding seed germination for all crops, indicating a delay of three days when seeds were placed in peanut shell media. The combinations of peanut shell media that were evaluated yielded the biggest percentage of seed germination for the variety of crops that were studied. T3 (50% peat moss + 50% peanut shell) was found to be the most effective mixture. These findings underscore the crucial role of media composition in both seed germination and seedling growth.

Table 3: Effect of peat moss and peanut shell media on seeds germination percentage (%).

Treatment	Beans	Cucumber	Tomatoes	Cantaloupe	Zucchini	Cabbage	Lettuce
T1	99	99	99	98	97	99	99
T2	98	97	97	97	96	97	98
T3	100	100	100	100	100	100	100
T4	98	98	98	97	96	98	98
T5	99	99	99	98	97	99	99

T_1: peat moss and vermiculite 1:1 (v/v), T_2: 75% peat moss + 25% peanut shell, T_3: 50% peat moss + 50% peanut shell, T_4: 25% peat moss + 75% peanut shell and T_5: 0% peat moss + 100% peanut shell

Regarding the effect of different mixtures of peanut shell and peat moss nursery media on the fresh weight (g/plant) of vegetable seedlings, the results in Table (4) demonstrate that there were no notable variances between the traditional and alternative mixtures concerning seedling growth parameters across all crops (bean, cucumber, tomato, cantaloupe, zucchini, cabbage and lettuce) following at the particular date of every crop, particularly regarding fresh weight. It was observed that the highest fresh weight among all crop seedlings was achieved with the T3 (50% peat moss + 50% peanut shell) mixture in both seasons. This suggests that there may be stimulatory substances present in peanut shell, which could account for this response.

Table 4: Effect of different mixtures, of peanut shell and peat moss nursery media on fresh weight (g/plant) of vegetables seedlings.

	Season 1						
Treatment	**Bean**	**Cucumber**	**Tomato**	**Cantaloupe**	**Zucchini**	**Cabbage**	**Lettuce**
T1	15.3b	9.6b	10.4b	14.2bc	14.36b	12.1b	10.2b
T2	15c	9.5c	10.1c	14.1c	14.1c	12.1b	10.1b
T3	16.1a	9.7a	10.8a	15.3a	15.1a	13.2a	11.2a
T4	15 c	9.5c	10.1c	14.2bc	14.1c	12.1b	10.1b
T5	15.3b	9.6b	10.4b	14.3b	14.3b	12.1b	10.2b
	Season 2						
Treatment	**Bean**	**Cucumber**	**Tomato**	**Cantaloupe**	**Zucchini**	**Cabbage**	**Lettuce**
T1	16.7b	9.5b	10.4b	14.1b	14.4b	10.8c	10.1c
T2	16.1e	9.4c	9.8e	13.8d	13.8e	11.1b	10.3b
T3	17.2a	9.7a	10.8a	15.4a	15.3a	12.3a	11.4a
T4	16.2d	9.3d	10.1d	14.1c	14.1d	11.1b	10.1c
T5	16.6c	9.5b	10.3d	14.1b	14.3d	10.7c	9.8d

T1: peat moss and vermiculite 1:1 (v/v), T2: 75% peat moss + 25% peanut shell, T3: 50% peat moss + 50% peanut shell, T4: 25% peat moss + 75% peanut shell and T5: 0% peat moss + 100% peanut shell

The results from Table (5) showed the effect of different mixtures of peanut shell and peat moss nursery media on the dry weight (g/plant) of vegetable seedlings the data illustrated that, after the particular date of each seedling crops (bean, cucumber, tomato, cantaloupe, zucchini, cabbage and lettuce) there were no appreciable variations in the characteristics of seedling growth between the conventional and alternative combinations for any of the crops, especially in terms of dry weight. Interestingly, the T3 (50% peat moss + 50% peanut shell) mixture consistently led to the highest dry weight among all crops (bean, cucumber, tomato, cantaloupe, zucchini, cabbage and lettuce) seedlings, while T4 (75% peat moss + 25% peanut shell) mixture gave the smallest dry weight for all crops in both seasons.

Table 5: Effect of different mixtures of peanut shell and peat moss nursery media on dry weight (g/plant) of vegetables seedlings.

	Season 1						
Treatment	**Bean**	**Cucumber**	**Tomato**	**Cantaloupe**	**Zucchini**	**Cabbage**	**Lettuce**
T1	1.3b	0.56b	0.39bc	1.4b	0.86c	0.84b	0.81b
T2	1.2c	0.54d	0.41b	1.3c	0.86bc	0.86b	0.82b
T3	1.4a	0.59a	0.45a	1.5a	0.95a	1.86a	1.46a
T4	1.2c	0.53e	0.39c	1.3c	0.85c	0.85b	0.82b
T5	1.2c	0.55c	0.39c	1.3c	0.87b	0.55b	0.82b
	Season 2						

Table 5 (Cont.): Effect of different mixtures of peanut shell and peat moss nursery media on dry weight (g/plant) of vegetables seedlings.

Treatment	Bean	Cucumber	Tomato	Cantaloupe	Zucchini	Cabbage	Lettuce
T1	1.4b	0.57ab	0.42bc	1.46b	0.87b	0.85b	0.82b
T2	1.3b	0.55ab	0.42b	1.43b	0.87b	0.87b	0.82b
T3	1.5a	0.59a	0.41a	1.63a	0.96a	1.96a	1.56a
T4	1.3b	0.54b	0.39d	1.46b	0.86b	0.86b	0.83b
T5	1.3b	0.56ab	0.41c	1.43b	0.88b	0.89b	0.83b

T1: peat moss and vermiculite 1:1 (v/v), T2: 75% peat moss + 25% peanut shell, T3: 50% peat moss + 50% peanut shell, T4: 25% peat moss + 75% peanut shell and T5: 0% peat moss + 100% peanut shell

The presented data in Table (6) illustrated that the T3 (50% peat moss + 50% peanut shell) mixture consistently gave the highest values for seedlings among all crops, while the lowest values were given by T2 for (cantaloupe, zucchini and cabbage) and T5 for (bean, cucumber, tomato and lettuce) crops in both seasons after the specific date of each seedling crop. However, it's noteworthy. This observation suggests the presence of stimulatory substances in peanut shell, potentially contributing to the enhanced growth response seen with the T3 mixture.

Table 6: Effect of different mixtures of peanut shell and peat moss nursery media on vegetables seedling length (cm).

	Season 1						
Treatment	Bean	Cucumber	Tomato	Cantaloupe	Zucchini	Cabbage	Lettuce
T1	20.3b	21.1c	22.8b	21.4b	20.7b	12.2b	12.1b
T2	20.2b	20.2d	21.5d	20.7d	20.1d	12.1d	12.1b
T3	24.4a	23.3a	24.6a	22.2a	22.5a	17.1a	14.1a
T4	20.2b	21.8bc	21.7c	20.5e	20.1d	12.1d	12.1b
T5	20.2b	22.1b	22.7b	21.2c	20.5c	12.1c	12.1b
	Season 2						
Treatment	Bean	Cucumber	Tomato	Cantaloupe	Zucchini	Cabbage	Lettuce
T1	20.7b	22.1b	22.7b	21.7b	20.7b	15.1c	6.1bc
T2	19.7c	20.4d	21.6d	20.7d	19.6e	12.1e	6.2b
T3	22.2a	23.1a	24.6a	22.3a	22.6a	17.1a	9.3a
T4	19.2d	19.8e	21.5e	21.2c	19.8d	13.1d	6.1c
T5	20.7b	21.8c	22.6c	20.8d	20.5c	15.4b	6.1bc

T1: peat moss and vermiculite 1:1 (v/v), T2: 75% peat moss + 25% peanut shell, T3: 50% peat moss + 50% peanut shell, T4: 25% peat moss + 75% peanut shell and T5: 0% peat moss + 100% peanut shell

With regard to the effect of different mixtures of peanut shell media and peat moss nursery media on vegetables seedling stem diameter (mm), the results from Table (7) are presented that when comparing the metrics of seedling growth for all crops following the particular date of each seedling crop (bean, cucumber, tomato, cantaloupe, zucchini, cabbage and lettuce), there were no significant differences between the traditional and alternative mixtures, especially regarding stem diameter. Interestingly, the T3 (50% peat moss + 50% peanut shell) mixture consistently yielded the highest stem diameter among all crop seedlings, while the lowest values were gavin by T5 (0% peat moss + 100% peanut shell) mixture for (bean, tomato and zucchini) and T4 (25% peat moss + 75% peanut shell) mixture for (cucumber and cantaloupe) crops in both seasons.

Table 7: Effect of different mixtures of peanut shell media and peat moss nursery media on vegetables seedling stem diameter (mm).

	Season 1				
Treatment	Bean	Cucumber	Tomato	Cantaloupe	Zucchini
T1	2.3ab	3.3ab	3.1b	2.9b	3.1b
T2	2.1b	2.3c	2.8b	2.8bc	3.06b
T3	2.5a	3.4a	3.8a	3.8a	3.5a
T4	2.1b	2.5c	3.1b	2.7c	3.1b
T5	2.3ab	3.1b	3.1b	2.9bc	3.1b
	Season 2				
Treatment	Bean	Cucumber	Tomato	Cantaloupe	Zucchini
T1	2.1c	3.1b	3.5b	3.1b	3.2b
T2	1.8d	3.1b	3.4cd	2.8c	3.1b
T3	2.6a	3.7a	3.8a	3.3a	3.6a
T4	1.8d	3.1b	3.3d	2.7d	3.1b
T5	2.2b	3.2b	3.4bc	3.1b	3.2b

T1: peat moss and vermiculite 1:1 (v/v), T2: 75% peat moss + 25% peanut shell, T3: 50% peat moss + 50% peanut shell, T4: 25% peat moss + 75% peanut shell and T5: 0% peat moss + 100% peanut shell

Referring to the results in Table (8) data indicated that the peak of values for the average number of leaves and leaves area (cm2) were given when using T3 (50% peat moss + 50% peanut shell) mixture treatment, while the smallest values were given when using T2 (75% peat moss + 25% peanut shell) mixtures for (cabbage and lettuce) crops in both seasons. There were no significant differences between the traditional and alternative mixtures concerning seedling growth parameters across (cabbage and lettuce) crops after the specific date of each seedlings crop.

Table 8: Effect of different mixtures of peanut shell and peat moss nursery media on seedlings average number of leaves and leaf area (cm²).				
	Season 1			
	Cabbage		**Lettuces**	
Treatment	**Average Number of leaves**	**Leaves area (cm²)**	**Average Number of leaves**	**Leaves area (cm²)**
T1	5.4b	9.1bc	3.5b	7.1b
T2	5.1c	8.9c	3.5b	6.9bc
T3	6.2a	10.1a	4.7a	9.2a
T4	5.1c	9.1bc	3.4b	6.7d
T5	5.3b	9.2b	3.3b	6.9cd
	Season 2			
T1	5.4b	9.1c	3.2c	7.2b
T2	5.2c	9c	3.4b	7.1b
T3	6.3a	10.1a	3.9a	9.2a
T4	4.9d	9.1c	3.1c	6.7c
T5	5.1c	9.2b	3.2c	7b

T1: peat moss and vermiculite 1:1 (v/v), T2: 75% peat moss + 25% peanut shell, T3: 50% peat moss + 50% peanut shell, T4: 25% peat moss + 75% peanut shell and T5: 0% peat moss + 100% peanut shell

The presented data in Tables (9), (10) and (11) demonstrate the effect of different mixtures of peanut shell and peat moss nursery media on the seedling NPK contents. Data observed that the NPK contents were increased with the T3 (50% peat moss + 50% peanut shell) mixture, whilst the lowest data were given by using T4 (25% peat moss+75% peanut shell) mixture this effect was consistent across both seasons, While noticed that there were no significant differences in seedling growth parameters between traditional and alternative mixtures across all crops after at the specific date of each seedling crop, this trend was confirmed in both seasons. Peanut shell are known to be rich in carbon (C) and nitrogen (N), with a (C/N) ratio that can vary from 50 to 150, which can limit the composting process due to the high C/N ratio. However, this high C/N ratio can be decreased by increasing the basal N content of peanut shell, which can be achieved by adding manure, readily available in Egypt. This suggests that enhancing the N content of peanut shell through the addition of manure could potentially optimize their effectiveness as a growing medium, leading to increased seedling NPK contents.

Table 9: Effect of different mixtures of peanut shell and peat moss nursery media on the nitrogen content of vegetables seedlings (% of the dry matter).							
	Season 1						
Treatment	**Bean**	**Cucumber**	**Tomato**	**Cantaloupe**	**Zucchini**	**Cabbage**	**Lettuce**
T1	2.6b	3.7b	3.16	3.9c	3.2b	3.7b	4.3b
T2	2.5b	3.6bc	2.9c	4bc	2.8d	3.6b	4.2c
T3	2.8a	4.1a	3.4a	4.5a	3.7a	4.1a	4.7a
T4	2.5b	3.6c	2.8c	3.9c	2.7e	3.5b	4.1d
T5	2.6b	3.6bc	3.1b	4.1b	3.1c	3.6b	4.3b
	Season 2						
Treatment	**Bean**	**Cucumber**	**Tomato**	**Cantaloupe**	**Zucchini**	**Cabbage**	**Lettuce**
T1	2.7a	3.8b	3.1b	4.1b	3.3b	3.9b	4.4b
T2	2.5b	3.7bc	3b	4b	2.9d	3.6d	4.3bc
T3	2.8a	4.2a	3.5a	4.5a	3.9a	4.1a	4.8a
T4	2.5b	3.6cd	2.8c	3.9b	2.8d	3.5e	4.2d
T5	2.7a	3.5d	3.1b	4b	3.2c	3.7c	4.3cd

T1: peat moss and vermiculite 1:1 (v/v), T2: 75% peat moss + 25% peanut shell, T3: 50% peat moss + 50% peanut shell, T4: 25% peat moss + 75% peanut shell and T5: 0% peat moss + 100% peanut shell

Table 10: Effect of different mixtures of peanut shell and peat moss nursery media on the phosphorus content of vegetables seedlings (% of the dry matter).							
	Season 1						
Treatment	**Bean**	**Cucumber**	**Tomato**	**Cantaloupe**	**Zucchini**	**Cabbage**	**Lettuce**
T1	0.19b	0.23b	0.44b	0.49b	0.24b	0.79b	0.86b
T2	0.19b	0.21d	0.42d	0.46c	0.22c	0.59c	0.91b
T3	0.25a	0.28a	0.51a	0.51a	0.26a	1.02a	1.01a
T4	0.18c	0.21d	0.42d	0.43e	0.22d	0.59c	0.89b
T5	0.19b	0.22c	0.43c	0.44d	0.24b	0.79b	0.91b
	Season 2						
Treatment	**Bean**	**Cucumber**	**Tomato**	**Cantaloupe**	**Zucchini**	**Cabbage**	**Lettuce**
T1	0.18bc	0.24b	0.45b	0.51b	0.26a	0.86b	0.91d
T2	0.19bc	0.22d	0.43d	0.48c	0.24b	0.66c	0.92c
T3	0.25a	0.29a	0.52a	0.52a	0.27a	1.04a	1.03a
T4	0.18c	0.21e	0.43d	0.44d	0.22c	0.59d	0.91cd
T5	0.19b	0.23c	0.44c	0.45d	0.24b	0.81b	0.93b

T1: peat moss and vermiculite 1:1 (v/v), T2: 75% peat moss + 25% peanut shell, T3: 50% peat moss + 50% peanut shell, T4: 25% peat moss + 75% peanut shell and T5: 0% peat moss + 100% peanut shell

Table 11: Effect of different mixtures of peanut shell and peat moss nursery media on the potassium content of vegetables seedlings (% of the dry matter).

	Season 1						
Treatment	**Bean**	**Cucumber**	**Tomato**	**Cantaloupe**	**Zucchini**	**Cabbage**	**Lettuce**
T1	2.2b	3.5b	5.1b	3.2b	2.4b	5.2b	3.8b
T2	2.1d	3.2c	4.8cd	2.9c	2.3c	4.9c	3.5c
T3	2.6a	3.8a	5.9a	3.7a	2.7a	5.6a	4.2a
T4	2.1c	3.1c	4.8d	2.9c	2.4bc	4.7d	3.5c
T5	2.2c	3.4b	4.9c	3c	2.3c	4.9c	3.4c
	Season 2						
Treatment	**Bean**	**Cucumber**	**Tomato**	**Cantaloupe**	**Zucchini**	**Cabbage**	**Lettuce**
T1	2.3c	3.6ab	5.2b	3.3b	2.5b	5.3b	3.9b
T2	2.2e	3.3b	4.9c	3.1c	2.4c	5c	3.6c
T3	2.8a	3.9a	6.1a	3.8a	2.8a	5.7a	4.3a
T4	2.6b	3.4b	4.9c	3c	2.5bc	4.8d	3.6c
T5	2.3d	3.5b	5.1b	3.1c	2.4c	5c	3.5c

T1: peat moss and vermiculite 1:1 (v/v), T2: 75% peat moss + 25% peanut shell, T3: 50% peat moss + 50% peanut shell, T4: 25% peat moss + 75% peanut shell and T5: 0% peat moss + 100% peanut shell

3.1 Economic evaluation

A comparison between the price of peat moss and peanut shell depends on several factors such as geographical location, suppliers, quantities purchased, product quality, and others. However, some general guidelines can be provided. Peat moss is often more expensive than peanut shell. This is partially due to peat moss is imported product which typically manufactured and processed with additional nutrients, which increases its cost in addition to the environmental cost. Peanut shell can generally be less expensive because they are usually available in large quantities at a lower cost, especially if locally sourced. In some cases, there may be additional shipping costs for peat moss if it is imported from distant regions, while Sudanese peanut husks can be available locally at a lower cost and without additional shipping expenses. The price of a bale of peat moss (400 liters) equivalent to about 60-65 kilograms is approximately 1600 Egyptian pounds. Meanwhile, peanut shell is priced at around 4200 Egyptian pounds per ton. With a simple calculation, the cost per kilogram of peat moss is about 24 Egyptian pounds, while the cost per kilogram of peanut shell is about 0.24 Egyptian pounds and may be reached to 0.5 Egyptian pound after adding the machinery cost. In general, the appropriate material is chosen based on actual needs and availability in the local market, in addition to the prices, technical features, and environmental considerations available.

4. Discussion

Vegetable Seedlings production is considered the cornerstone of the production process of vegetable crops, whether as an open field or under greenhouse conditions. Providing vegetable seedlings with good health specifications, as well as focus on the sustainability of the seedling production process. Also, taking into account the environmental effects of consuming peat moss and its high price constitutes the driving force in the attempt to replace the use of peat moss as a primary environment for the nursery with a renewable environment, while at the same time achieving an economic goal by reducing the costs of producing seedlings.

Grounded peanut shell for alternating peat moss as a seedling substrate could play a vital sustainable role as a renewable source of substrate besides recycling peanut shell in economic value and offering promising prospects for sustainable and environmentally friendly nursery practices. The results indicate that the mixture of 50% traditional nursery substrate and 50% peanut shell (T3) showed superior performance in terms of seedling dry weight, seedling fresh weight, seedling stem diameter, seedling length, seedling leaf area, number of leaves, and nutrient content (NPK) for various vegetable seedlings such as beans, cucumber, cantaloupe, zucchini, tomatoes, cabbage, and lettuce. Despite causing a delay in germination, the use of peanut shell in the nursery media did not significantly reduce overall germination rates. This combination of nursery substrate (T3) consistently delivered the best outcomes across all evaluated parameters, suggesting its effectiveness in supporting robust seedling growth and development in the studied crops. The improvement in physical and chemical properties of the substrate, as shown in Table (2), likely contributed to these positive results compared to traditional seedling media. Additionally, the enhancement of nutrient content in the substrate is believed to have played a crucial role, aligning with findings from researchers, which emphasize optimizing NPK application methods to enhance nutrient efficiency and utilization in nursery production systems (Garcia et al., 2020). These findings offer practical insights and recommendations for growers seeking to improve seedling quality and overall crop productivity through strategic use of nursery substrates enriched with peanut shell.

The potential of peanut shell media as a viable option for supporting seedling growth had been studied by (Kabir et al., 2019; Smith et al., 2020; Ullah et al., 2020; Chen et al., 2021; Garcia et al., 2021). Their results also indicate promising potential for peanut shell in supporting the growth and development of cabbage, tomato, cucumber and pepper seedlings, suggesting its suitability as a sustainable alternative to conventional nursery substrates and for organic vegetable production. They found that the peanut shell substrate promoted favorable root development and enhanced seedling vigor compared to other substrates. This indicated the potential of peanut shell to serve as an effective nursery medium for vegetable seedlings.

These studies collectively highlight the potential of peanut shell and its derivatives as viable substrates or soil amendments for enhancing the growth and yield of various vegetable crops. Therefore, incorporating peanut shell or derived substances into agricultural mixtures could be an effective strategy for promoting seedling growth, which holds promise for optimizing agricultural practices and improving crop yields. Further research in this area is essential to explore optimal utilization methods and maximize the benefits of peanut shell in vegetable cultivation as well as to refine the composition of peanut shell media could lead to minimizing germination delays while maximizing seedling growth, thus enhancing its overall effectiveness in agricultural applications.

5. Conclusions

The need to alternate peat moss use as a substrate by renewable sources of organic substrate such as peanut shell, coco peat or others become more important due to environmental concerns. Under Egyptian conditions, peanut shell is available and lower cost compared to coco peat. Recycle peanut shell as a substrate also has an environmental and economic benefits as well as adapted to climate change. The study strengthen the local alternative source instead of peat moss that promote the seedlings production impact. The most favorable treatment was peat moss and grounded peanut shell 50%:50% (*v/v*), (T_3) presented the best vegetative growth characteristics of different vegetable seedlings (bean, cucumber, tomatoes, cantaloupe, zucchini, cabbage and lettuce) under this study and economic perspectives.

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