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ORIGINAL RESEARCH ARTICLE

CrossMark

Effect of different growing media on growth and yield of leafy vegetables in nutrient film technique hydroponics system

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ABSTRACT

The purpose of this study was to determine the effect of growing media on the growth and yield of leafy vegetables in the Nutrient Film Technique (NFT) of Hydroponic cultivation. This research was carried out for two months (Nov to Dec 2020) in the research house of Wind Power Nepal Pvt. Ltd, located at an altitude of 1310 meters above sea level. The experimental design used in this study was a factorial randomized block design (RBD) with two factors. The first factor was growing media; namely cocopeat, sponge, and perlite. The second factor was crop types namely lettuce and pakchoi that were harvested in 30 days. The data were subjected to the ANOVA technique in R-studio software version 4.0.0 and Fisher's protected LSD test was used to separate the means. The highest plant yield (12.55 g) was obtained from plants grown in cocopeat in the NFT hydroponics system. The longest plant shoot height (9.69 cm) was obtained from plants grown in the sponge, while the lowest plant shoot height (8.85 cm) was observed in plants grown in perlite. The broadest plant leaf width (5.54 cm) was observed in plants grown in the cocopeat when compared to the sponge (4.93 cm) and perlite (4.32 cm) growing media. The results of this study showed that growing media cocopeat followed by sponge performed better as compared to perlite. The combination of the two factors showed an insignificant result in growth and yield parameters. For the hydroponics cultivation of lettuce and pakchoi, cocopeat followed by sponges should be used as a growing medium for better growth and yield.

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INTRODUCTION

Hydroponics is a technology for growing plants in nutrient solution with or without the use of artificial media (sand, gravel, vermiculite, rockwool, perlite, peatmoss or sawdust) to provide mechanical support (Musa, 2019). In hydroponics cultivation system, the interaction between the plant, growing medium and nutrient solution determines the efficacy of the growing environment (Roosta and Afsharipoor, 2012). The most important factors governing the interaction between a growing medium and the nutrient solution are porosity, water holding capacity, water availability, buffering capacity, and cation exchange capacity (CEC) (Woottan-Beard, 2019). Lettuce is an excellent source of vitamin K and vitamin A with higher concentrations of the provitamin A compound, beta-carotene. 100 grams of lettuce contains 15 calories. The United States has the largest production of lettuce as a salad crop and has produced 22 % of the world's lettuce supply on only 13% of the total lettuce production area in the world (Ryder, 1999). Lettuce is also grown widely in large areas in India, Japan, Mexico and Turkey. Packchoi (*Brassica rapa subsp. Chinensis*), also known as Chinese cabbage celery is an annual plant that belongs to the family

Brassicaceae. In a 100-gram reference serving, pakchoi provides 13 kilocalories of food energy and is a rich source of vitamin A , vitamin C and vitamin K, while providing folate, vitamin B6 and calcium in moderate amounts.

Field soils are generally unsatisfactory for the production of plants in containers because soils do not provide the aeration, drainage, and water holding capacity required and they need to be pasteurized or fumigated to prevent diseases and weeds. Different growing media like sand, perlite, gravel, cocopeat, or sawdust perform mechanical substitutes of soil in hydroponics cultivation. Non-soil growing media can be used to provide mechanical support to the roots which support the plant's weight and hold it upright (Gaikwad and Maitra, 2020). These provide maximum exposure of roots to nutrient solution in a hydroponic structure. Media like cocopeat has a distinct quality for holding water for a longer period and has anti-fungal properties. It provides ample microclimate conditions in the root region of plants and increased their height, the number of leaves, and fresh biomass components (Sarkar *et al*., 2021). The typical pH range for cocopeat is 5.5–6.8; it contains significant amounts of phosphorus (6–60 ppm) and potassium (170–600 ppm) (Domingues Salvador *et al*., 2005). Soilless production also takes place using foam substrates (Bumgarner and Hochmuth, 2019) and perlite. Foam substrate is an inorganic growing media with high water holding capacity and mechanical support to plant roots. Perlite is an amorphous volcanic glass that is heated at high temperatures until the material expands. It is porous and has a high holding capacity. If the hydroponics system is flooded at any time, using perlite alone as a substrate might be inconvenient as it is lightweight and floats easily. Thus, it is usually used in conjunction with other substrates. The use of perlite provides improved aeration and drainage and optimum moisture retention and nutrient availability (Gruda *et al*., 2013).

Recently NFT is gaining wide popularity among growers because of its low installment cost, the rapid turnaround between crops, and precise control of nutrients (Rabiya, 2012). NFT is recirculated design to run highly oxygenated dissolved nutrients continuously over the roots of plants through a set of channels, typically grown in baskets hanging in a PVC pipe. The solution is pumped from a holding tank, through irrigators at the top of every sloping pipe and the run-off from the bottom of the channels is returned to the tank. Thus, the nutrient solution is continuously recycled (El-Kazzaz and Kaei-Kazzaz, 2017). Among factors affecting hydroponics production systems, the nutrient solution is considered to be one of the most important determining factors of crop yield and quality (Trejo-Tellez and Gomez-Merino, 2012). The water-soluble nutrients used in hydroponics are mostly inorganic and in the ionic form. The main nutrients include dissolved cations (positively charged ions) like Ca^{2+} (calcium), Mg^{2+} (magnesium), and K^+(potassium) and the main nutrient solution in the form of anions (positively charged ions) are NO_3(nitrate), SO_4^{2-} (sulfate), and H_2PO_4 (dihydrogen phosphate) (Purba *et al*., 2021). Shah *et al.* (2009) found from the study that the average number of fruits plant, average fruit weight, stem length (3.57 m and 3.46 m), and averages were significantly higher for plants grown in ½ and full-strength Cooper's solutions as compared to the plants grown in corresponding strengths of Imai's solution.

Because of rapid urbanization and modernization, cultivable land is less in area, and conventional agriculture does not fulfill the escalating demand of the growing population. Nepal is one of the world's top ten fastest urbanizing countries with an annual urbanization rate of 3 percent (UN, 2016). Hydroponic farming has wide scope for mitigating the threats imposed by rapid urbanization poses on our agricultural system. The hydroponics production depends on several factor such as growing media, electrical conductivity, pH, temperature of nutrient, crops, and the type of hydroponic system. These factors determine the growth and yield parameters of crops in a hydroponics cultivation. The cocopeat, perlite, vermiculite is some mineral based growing media commonly used by the hydroponic growers in Kathmandu valley. Another most generally used media like the foam substrate also known as sponge has extensive scope in terms of reuse. However, there are very limited study on the use of foam substrate as a growing media in the hydroponics cultivation. Nepal seeks for sustainable future in hydroponics cultivation; therefore, use of readily available, economical and environmentally friendly growing media needs to be highly encouraged. Urban adaptability of hydroponic culture also depends on effectiveness of growing media on plant growth and yield. Hence, this study acknowledges the limitation and vitalizes the need for study on locally available materials for hydroponics cultivation. The purpose of this study was to determine the effect of different types of growing media, crop types, and interactions of growing media and crop types on the growth and yield in the NFT hydroponics cultivation system.

MATERIALS AND METHODS

Experimental site

A field experiment was conducted at Wind Power Nepal Pvt. Ltd, Jhamsikhel, Lalitpur, Nepal (Figure 1). The experiment was carried out from 20th Nov 2020 to 19th Dec 2020. The experimental field was located in the subtropical region at 1310 meters above sea level and located geographically at 27° 41' 4" North latitude and 85° 18' 27" east longitude. The temperature during the experiment was recorded at a maximum of 21° Celsius and a minimum of 5° Celsius with precipitation ranging from 0 mm to 2.2 mm.

Experimental design

In the experiment, a total of six treatments were used to see their performance in 2 factorial RBD in four replications. The Nutrient Film Technique Hydroponics system used for the experiment had 120 holes for120 plants (Figure 2). The dimension was 5ft×2.5ft×5ft with three tiers, each tier holding 4 interconnected PVC pipes. Each PVC pipe had 10 holes, holding 40 holes in each tier and 120 holes in total. Each hole had a diameter of 6 cm at a distance of 8 cm. One of the factors for the experiment was crop type. The crops used were Lettuce and Pakchoi, the

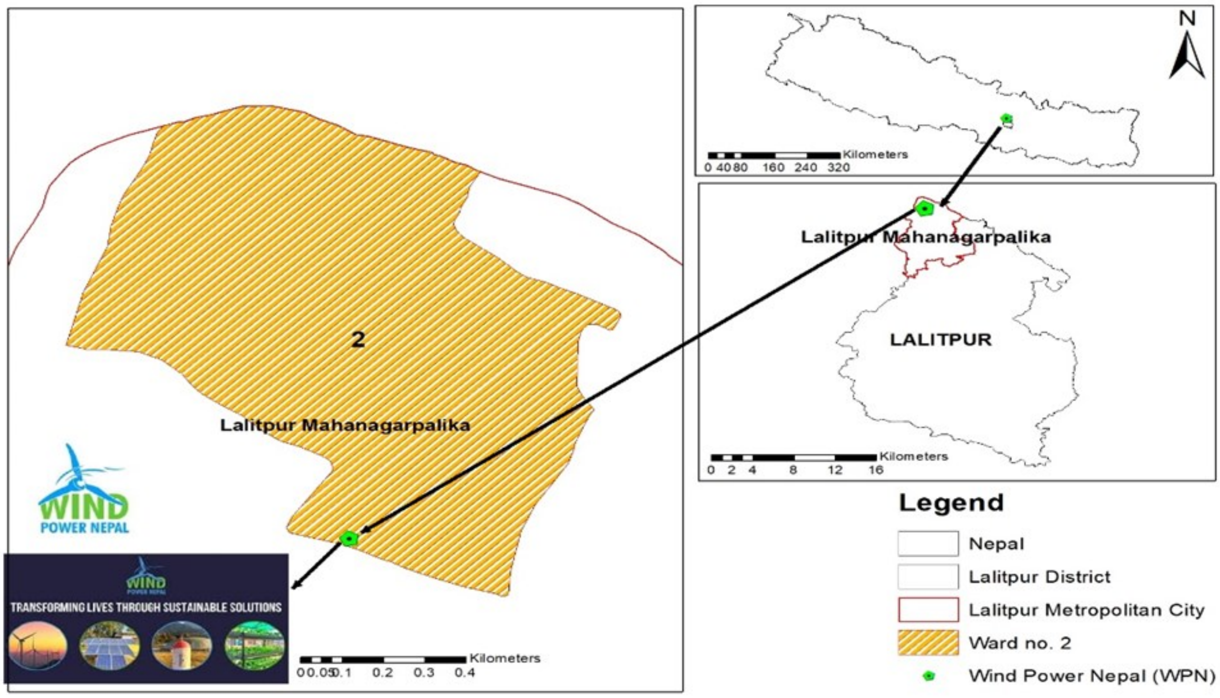

Figure 1. *Study area.*

Figure 2. *NFT System at Transplantation.*

Figure 3. *Treatments.*

Figure 4. *NFT System at 18 DAS.*

most popularly consumed salad crops in households of Nepal. The other factor was growing media and the types used in in the experiment was sponge, cocopeat, and perlite. The tools used in this research were: TDS meter, pH meter, measuring cup, tweezers, knife, scissors, scale, and writing tools. Figure 2 represents the pictures taken during the experiment.

Cultivation practices and data collection

The seedlings were grown on the seedling tray of 35 holes with 4.5 cm depth. The seedling mixture for substrate was used in the 1:1 ratio of cocopeat and organic fertilizer. The cocopeat was sun-dried for solarization to kill insects and diseases. The seeds were sown on 29th October 2020. The seeds were soaked in water for 24 hours. Two seeds per hole were seeded at a depth of ¼ inch. The seedling tray was placed in a water tray of (40×28.5) cm dimension for moisture. All seedlings were irrigated every day in the evening. When the seeds emerged, the tray was placed within the sunlight area. The seedlings of 3 to 4 leaves were thinned to the strongest plant per hole on 12th November 2020. The seedlings of 4 to 5 matured leaves were finally transplanted into the system on 20th November 2020. Three different growing media like sponges, cocopeat, and perlite were used in the NFT hydroponics system for mechanical support to the seedlings. The respective growing media were placed in a netted cup and plastic cups of length 10 cm, top diameter 7.5 cm, and bottom diameter 5 cm. The suitable sizes holes were made in plastic cup for water flow and root growth. Table 1 shows the average weight of growing medias and cups. The hydroponics system was run with 60 liters of water,24 hours a day. The capacity of reservoir was 60 liters. The motor of 18 Watt was used to circulate water in the system. Alan Cooper's formulation-based nutrient was applied at the time of system set up. 5 ml of each nutrient A and B per liter of water was applied with a total of 300 ml each. The EC, pH, and TDS were measured with the TDS meter and pH meter, and data were recorded accordingly. Table 2 shows the respective readings of EC, pH and TDS on different dates. The nutrient and water were added at 25% of the initial volume at intervals of 7 days. Nimbicide, a biopesticide was used twice at an interval of a week to control aphids' infestation after 1st week. 3 ml of nimbicide per liter of water was sprayed with a hand sprayer.

Lettuce and pakchoi were harvested after 30 days. Harvesting was done by pulling out the plant and its net pot, then the plant was separated from the net pot. Each observation was recorded after 5 days of transplantation at an interval of 5 days for 5 times on plant shoot length, plant leaf width, plant root length,

Table 1. The average weight of growing media and cups.

S.N.	Particulars	Average weight (g)
1	Cocopeat	18.6
2	Perlite	23.8
3	Sponges	6.6
4	Netted cup	11.6
5	Plastic cup	3.7

Table 2. The EC, pH, TDS and temperature measurement on the following days.

Date	EC (dS/m)	pH	TDS (ppm)	Temperature of water (°C)
20th Nov 2020	2.5	7.4	1296	18
25th Nov 2020	2.1	5.8	1134	19
1st Dec 2020	3.1	6.2	1535	19
7th Dec 2020	2.2	5.9	1134	16
13th Dec 2020	2.3	5.7	1178	17
19th Dec 2020	2.1	5.8	1134	18
Average	2.3	6	1235	18

Table 3. Treatment used in the study.

Treatments	
T1	Lettuce with cocopeat
T2	Lettuce with sponge
T3	Lettuce with perlite
T4	Pakchoi with cocopeat
T5	Pakchoi with sponge
T6	Pakchoi with perlite

and the total number of leaves per plant. The fresh shoot weight and fresh root weight were taken at harvest after 30 days of transplantation. The data were recorded from 72 plants out of 120 plants; three plants per replication. The data from the results of this study were analyzed statistically to check if there were significant differences between treatments using R-studio version 4.0.0 followed by the Fisher's protected LSD test at the 5% level. Table 3 shows the treatments used in this study.

Statistical analysis

The data were subjected to the ANOVA technique by applying R -studio software in agricolae and gvlma package and Fisher's protected LSD test was used to separate the means.

RESULTS AND DISCUSSION

Plant yield

The study revealed that the plant shoot yield was significantly influenced by growing media in hydroponics. The average plant shoot yield was 9.2 g whereas the average plant root yield was 2.62 g at harvest (30 DAS). The shoot yield and root yield were statistically highest with cocopeat growing media. Whereas the shoot yield and root yield were recorded statistically lowest with perlite as growing media. Similarly, the shoot yield and root yield were statistically higher in lettuce than pakchoi. However, the plant yield was not significantly influenced by the interaction of different growing media and crop types. The highest plant shoot yield was recorded at the interaction of lettuce and cocopeat followed by interaction of pakchoi and cocopeat and interaction of pakchoi and sponge. Whereas, the plant shoot yield was statistically lowest at the interaction of pakchoi and perlite followed by the interaction of lettuce and perlite. Similarly, the plant root yield was statistically highest at the interaction between lettuce and cocopeat whereas lowest at the interaction between pakchoi and perlite (Table 4).

Plant shoot height

The study revealed that the plant shoot height was significantly influenced by crop types in hydroponics at each date of observation from 6 DAP to 30 DAP except for the 18 DAP. Whereas, the plant shoot height was significantly influenced by growing media at 12 DAP, 18 DAP, 24 DAP, and 30 DAP. The average plant shoot height varied from 3.87 cm at 6 DAP to 9.21 cm at harvest. The plant shoot height was statistically longest from 6 DAS to harvest with lettuce using sponge as a growing media. However, the plant shoot height was insignificant at the interaction between crop and growing media except for the harvest where it significantly influenced plant shoot height at 0.1, where the interaction of lettuce with sponge statistically showed the longest shoot yield. Statistically, the shortest shoot height was recorded in the interaction of pakchoi with perlite at harvest (Table 5).

Plant leaf width

The study revealed that plant leaf width is significantly influ-

Table 4. Plant shoot yield (g) and plant root yield influenced by different growing media and crop.

Treatments	Plant yield (g)	
	Plant shoot yield (g)	**Plant root yield (g)**
Cocopeat	12.55[ab]	3.13375[ab]
Sponge	10.15[c]	2.61250[c]
Perlite	4.9	2.12000
F-test	*	NS
LSD	5.481287	0
Lettuce	9.4[a]	3.103333[a]
Pakchoi	9[a]	2.140833[b]
F-test	NS	.
LSD	0	0.9494296
T1	13.975[ab]	4.3425[ab]
T2	9.175[e]	2.3250[e]
T3	5.050[f]	2.6425[d]
T4	11.125[c]	1.9250[f]
T5	11.125[d]	2.9000[c]
T6	4.750	1.5975
F-test	NS	NS
LSD	0	0
Sem (+-)	26.453	1.7599
CV, %	55.90487	50.59382
Grand Mean	9.2	2.622083

Note: *, **, ***, . and NS indicate significant at 0.05, 0.01, 0.001, 0.1 and insignificant, respectively.

enced by crop types in hydroponics at each date of observation from 6 DAP to 30 DAP Whereas the plant leaf width was significantly influenced by growing media at 12 DAP, 18 DAP, 24 DAP, and 30 DAP at 0.1 level of significance. The average plant leaf width varied from 1.87 cm at 6 DAP to 4.93 cm at harvest. The plant leaf width was statistically broadest from 6 DAS to harvest with lettuce. Similarly, the plant shoot height was statistically broadest with growing media cocopeat. However, the plant shoot height was insignificant at the interaction between crop and growing media. Statistically, the shortest leaf width was recorded in pakchoi and the use of perlite as growing media (Table 6).

Plant root length

The study revealed that plant root length is significantly influenced by crop types in hydroponics at a single date of observation at 6 DAP. Whereas the plant root length was significantly influenced by growing media at all dates of observation except at 12 DAP where no roots were visible in the growing pot. The average plant root length varied from 4.30 cm at 6 DAP to 10.44 cm at harvest. The plant root length was statistically longest from 6 DAP to harvest with lettuce. Similarly, the plant root length was statistically longest with growing media cocopeat. However, the plant root length was insignificant at the interaction between crop and growing media. Statistically, the shortest root length was recorded in pakchoi and use of perlite as growing media (Table 7).

Number of leaves

The study revealed that the number of leaves of plants is significantly influenced by crop types in hydroponics at all dates of observation. Whereas, the number of leaves of the plant was significantly influenced by growing media at harvest. The average number of leaves varied from 3.79 at 6 DAP to 7.95 at harvest. The number of leaves of the plant was statistically higher from 6 DAP to harvest with pakchoi. Similarly, the number of leaves of the plant was statistically higher with growing media cocopeat. However, the number of leaves of the plant was insignificant at the interaction between crop and growing media. Initially, the highest number of leaves of the plant was recorded in the interaction between pakchoi and use of perlite as growing media and lowest in the interaction between lettuce and perlite at the date of observation 6 DAP and 12 DAP After 18 DAP the number of leaves of the plant was recorded statistically higher in the interaction between pakchoi and sponge till the date of harvest. The lowest number of leaves of plants was recorded in the interaction between lettuce and perlite through all dates of observation till harvest (Table 8).

The results of the analysis of various effects of treatment on the observed variables showed that the treatment of the growing medium had a significant effect ($p \geq 0.05$) on plant shoot yield, plant shoot height at 18 DAP and 24 DAP, plant leaf width at 12 DAP, 18 DAP, 24 DAP, and 30 DAP, plant root length at 6 DAP and 24 DAP and number of leaves at 30 DAP but significant at ($p \leq 0.01$) on root length at 18 DAP and 30 DAP. However, the result is different from the result of a similar study by Purba *et al.* (2021), where the treatment of growing media had no significant effect ($p \geq 0.05$) on plant shoot yield, plant shoot height and number of leaves but significantly ($p \leq 0.01$) on root wet weight. best growing media is cocopeat followed by sponge compared to perlite. The cocopeat has a light and coarse characteristic so that air circulation is high, the ability to hold water is high. The sponge is an inorganic growing media with high water holding capacity and mechanical support to plant roots. Perlite has large

Table 5. Plant shoot height (cm) influenced by different growing media and crop.

Treatments	Plant shoot height (cm)				
	6 DAP	12 DAP	18 DAP	24 DAP	30 DAP
Lettuce	4.359167[a]	5.414167[a]	6.299167[ab]	8.403333[a]	9.662500[a]
Pakchoi	3.392500[a]	4.768333[a]	6.058333	6.846667[a]	8.758333[a]
F test	**	**	NS	**	**
LSD	0.7065969	0.5343364	NS	2.399305	1.152552
Cocopeat	3.54375	4.9000[b]	6.18000[c]	7.34750[a]	9.08250[b]
Sponge	4.20750[ab]	5.40625[a]	6.62375[ab]	8.05875[a]	9.69375[a]
Perlite	3.87625c	4.96750[b]	5.73250	7.46875[a]	8.85500[b]
F-test	NS	*	*	*	*
LSD	NS	0.3893292	0.7942881	2.126079	0.6075907
T1	3.0250	4.4100	6.1375[e]	7.7725[e]	9.0500[b]
T2	3.6850[e]	5.1400[e]	6.7925[ab]	9.2375[ab]	10.2025[a]
T3	3.4675[f]	4.7550[f]	5.9675[f]	8.2000[c]	9.7350[ab]
T4	4.0625[d]	5.3900[c]	6.6225[d]	6.9225[f]	9.1150[b]
T5	4.7300[ab]	5.6725[ab]	6.4550[c]	7.9050[d]	9.1850[b]
T6	4.2850[c]	5.1800[d]	5.4975	6.7375	7.9750[c]
F-test	NS	NS	NS	NS	.
LSD	NS	NS	NS	NS	0.859263
Sem (+-)	0.345	0.19729	0.29063	2.0823	0.4805
CV, %	15.1546	8.72425	8.725084	18.92482	7.526056
Grand Mean	3.875833	5.09125	6.17875	7.625	9.210417

Note: *, **, ***, . and NS indicate significant at 0.05, 0.01, 0.001, 0.1 and insignificant respectively.

Table 6. Plant leaf width (cm) influenced by different growing media and crops.

Treatments	Plant leaf width				
	6 DAP	12 DAP	18 DAP	24 DAP	30 DAP
Lettuce	2.033333[a]	2.757500[a]	3.436667[a]	4.876667[a]	6.122500[a]
Pakchoi	1.719167[a]	2.175833[a]	2.590833[a]	3.274167[b]	3.748333[b]
F test	*	***	***	***	***
LSD	0.3209528	nf	Inf	inf	inf
Cocopeat	1.89[ab]	2.5925[a]	3.09750[ab]	4.24625[a]	5.54875[a]
Sponge	2.02875[a]	2.605[a]	3.27250[a]	4.34625[a]	4.93250ab
Perlite	1.70[b]	2.2025[a]	2.67125[b]	3.63250[a]	4.32500[b]
F-test	*	*	*	*	*
LSD	0.233	1.367	0.582	0.8305863	1.0678
T1	1.8950[d]	2.8625[c]	3.4875[c]	5.0900[c]	6.0050[c]
T2	2.2425[ab]	2.9475[ab]	3.7350[ab]	5.1550ab	6.9850[ab]
T3	1.9625[c]	2.4625[d]	3.0875[d]	4.3850[d]	5.3775[d]
T4	1.8925[e]	2.3225[e]	2.7075[f]	3.4050[f]	4.1125[e]
T5	1.8150f	2.2625[f]	2.8100[e]	3.5375[e]	3.8600[f]
T6	1.4500	1.9425	2.2550	2.8800	2.2725
F-test	NS	NS	NS	NS	NS
LSD	NS	NS	NS	NS	NS
Sem (+-)	0.07118	0.8609	0.1563	0.3178	0.275
CV, %	14.89194	11.32744	13.118	13.53342	10.625
Grand Mean	1.87625	2.467	3.01375	4.075417	4.935417

Note: *, **, ***, . and NS indicate significant at 0.05, 0.01, 0.001, 0.1 and insignificant, respectively.

particles and low water holding capacity (Ilahi and Ahmad, 2017). Perlite is lightweight and floats. The use of perlite for mechanical support may be challenging if the system is flooded with perlite. Perlite when moist causes algal infestation affecting the root area and thereby water absorption by roots. The plant growth with perlite was poor compared to the plant growth with other growing media. The breakage of perlite granules into powder increases the floating capacity of perlite and their adherence to plant plants surface.

Treatment of lettuce varieties had a significant effect on shoot height except at 18 DAP at (p≤0.01), leaf width except at 6 DAP at (p≤0.001), root length at 6 DAP at (p≥0.05) and the number of leaves at 6 DAP, 24 DAP and 30 DAP at (p≥0.05) and 12 DAP and 18 DAP at (p≤0.01). However, it had no significant effect on root lengths at 12 DAP, 18 DAP, 24 DAP, and 30 DAP and plant shoot yield. The study showed that the use of lettuce in hydroponics gave the highest shoot yield of 12.55 g, root yield of 3.12 g, shoot length of 9.66 cm, leaf width of 6.12 cm, and root length of 10.46 cm compared to pakchoi with the shoot yield of 10.15 g, root yield of 2.61 g, shoot length of 8.75 cm, leaf width of 3.74 cm and root length of 10.41. However, the pakchoi had a higher number of leaves i.e., 9 compared to lettuce with 7. This is

Table 7. Root length of plants influenced by different growing media and crop.

Treatments	Root length				
	6 DAP	12 DAP	18 DAP	24 DAP	30 DAP
Lettuce	10.46833[a]	-	6.635[a]	8.271667[ab]	10.46833[ab]
Pakchoi	10.41500[a]	-	6.970[a]	8.131667	10.41500
F test	*	-			
LSD	0.79	-			
Cocopeat	4.38125[ab]	-	5.71625[c]	6.295[b]	8.96750[ab]
Sponge	3.76250[a]	-	9.45875[ab]	10.480[a]	6.875[c]
Perlite	3.76250[b]	-	5.23250	7.830[ab]	6.125
F-test	*	-	**	*	**
LSD	0.97	-	4.729	3.638325	5.481237
T1	3.7100[f]	-	5.0975[f]	5.9225	8.1825[f]
T2	4.5575[d]	-	10.0675[ab]	9.9750[c]	12.6150[c]
T3	3.6075	-	4.7400	8.917[d]	10.6075[d]
T4	5.0525[ab]	-	6.3350[d]	6.6675[e]	8.6250[e]
T5	5.0075[c]	-	8.8500[c]	10.9850[ab]	15.2925[ab]
T6	3.9175[e]	-	5.7250[e]	6.7425[e]	7.3275
F-test	NS	-	NS	NS	NS
LSD	NS	-	NS	NS	NS
Sem (+-)	0.43459	-	5.394	6.098	7.245
CV, %	15.29	-	34.14184	30.10867	25.77801
Grand Mean	4.30875	-	4.625	8.201667	10.44167

Note: *, **, ***, ˙ and NS indicate significant at 0.05, 0.01, 0.001, 0.1 and insignificant, respectively.

Table 8. Total number of leaves of plants influenced by different growing media and crops.

Treatments	Total leaves				
	6 DAP	12 DAP	18 DAP	24 DAP	30 DAP
Lettuce	3.250000[a]	4.3333[a]	3.436667[a]	5.916667[a]	7.16667[a]
Pakchoi	4.333333[a]	4.916667[a]	6.50000[a]	7.500000[a]	8.750000[a]
F test	***	**	**	***	***
LSD	0.7589	0.7589	0	inf	inf
Cocopeat	3.625	4.500	5.41667[a]	7.125[ab]	8.250[a]
Sponge	3.875[ab]	4.750[ab]	6.125[ab]	6.875[c]	8.375[a]
Perlite	3.875c	4.625[c]	5.875	6.125	7.250[a]
F-test	NS	NS	NS	NS	*
LSD	NS	NS	NS	NS	1.268
T1	3.00[f]	4.25[f]	5.50[f]	6.25[f]	7.25[f]
T2	3.50[e]	4.50[e]	5.50[e]	6.25[e]	7.50[e]
T3	3.25	4.25	5.25	5.75	6.75
T4	4.25[c]	4.75[d]	6.50[c]	8[c]	9[c]
T5	4.25[d]	5[c]	6.75[ab]	8[ab]	9.50[ab]
T6	4.50[ab]	5[ab]	6.25[d]	6.50[d]	7.75[d]
F-test	NS	NS	NS	NS	NS
LSD	NS	NS	NS	NS	NS
CV, %	12.66483	9.868796	11.01317	13.76604	10.82161
Grand Mean	3.791667	4.625	5.958333	6.708333	7.958333

Note: *, **, ***, ˙ and NS indicate significant at 0.05, 0.01, 0.001, 0.1 and insignificant, respectively.

because lettuce is able to adapt well to the NFT hydroponic system with the average recorded temperature of 18°C, average recorded pH of 6, and average electrical conductivity of 2.3 dS/m As in NFT hydroponics, it is important to consider the following factors: maintain the temperature in the solution between 13 and 15°C, pH must be in the range of 5.5 to 6.5, electrical conductivity (EC) should be around 1.5 to 3 mS cm^{-1} and the channels should have a slope of 1.5% to 2%

The combination of the use of growing media and crop types had no significant effect on plant shoot yield, plant root yield, plant shoot height, plant leaf width, root length, and the total number of leaves. However, it was significant at p≥1 on plant shoot height at 30 DAP. The results are similar to the results of the study by (Purba *et al.*, 2021) where the combination of the use of growing media and lettuce had no significant effect on plant shoot yield, plant shoot height and number of leaves. The study showed that the interaction between growing media and crop types altered each variable differently. The combination of the treatment of cocopeat growing media with lettuce had the highest plant shoot yield (13.97 g) and root yield (4.34 g). Whereas the combination of sponge growing media with pakchoi had the longest plant shoot height and plant leaf width compared to other combinations of treatments. While the combination of cocopeat and pakchoi had the longest root length, the combination of pakchoi and sponge had the highest number of leaves. On the contrary, the combination of pakchoi and perlite had the lowest yield, shoot height, leaf width, and root length. The poor water holding capacity compared to cocopeat might be the possible reason as perlite is used alone as a growing media. The perlite has large particles and poor water holding capacity (Ilahi and Ahmad, 2017). However, the problem can be solved by adding perlite to the cocopeat as it improves the physical and hydraulic characteristics of the media (Ilahi and Ahmad, 2017).

Conclusion

The highest yield, the broadest leaf width, the root length, and the number of leaves was obtained from plants grown using cocopeat in NFT hydroponics systems. However, the largest shoot height was observed in plants grown using the sponge in the NFT hydroponics system. The lowest plant yield and growth attributes were obtained from plants grown using perlite in the NFT hydroponics system. When compared with the yield and growth attributes of pakchoi, lettuce gives better growth and yield in the NFT hydroponic system. However, the interaction between growing media and crops has no significance on crop yield and growth performance. There is a great future in NFT hydroponics culture of leafy vegetables when cocopeat followed by the sponge is used as the growing media. However, the implications found in the study from the sole use of perlite as a growing media suggest the addition of perlite into cocopeat might enhance the physical properties of the media and growth attributes of the crop in the NFT hydroponic system.

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Conflict of interest

The authors declare there is no conflict of interest regarding the publication of this paper.

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