Research on lettuce cultivation with different substrates in greenhouse soilless environment and ecological protection value

Han Lin¹, ², *, Inshakov Sergey Vladimirovich²

¹Shenyang Institute of Technology, Shenyang, China
²Primorskaya State Agricultural Academy, Уссурийск, Россия

*Corresponding author: hanlin@situ.edu.cn

Abstract. In this paper, lettuce was used as the test material, and peat, perlite, coco peat and vermiculite were selected as the growth media for lettuce soilless culture. The three media were combined in different proportions for soilless culture, and the growth indicators of lettuce were selected. The most suitable ratio for lettuce.

1. Introduction
Substrate cultivation is one of soilless cultivation. Its key is to use the substrate to transport the water and nutrients in the nutrient solution. The substrate and the nutrient solution work together to complete the tasks of fixing and supporting plants, regulating oxygen, and supplying water and nutrients [1]. In the process of cultivation, the nutrients, humidity, pH and temperature of the rhizosphere change slowly, so the substrate has a certain buffering effect. Since substrate cultivation and soil cultivation have many similarities, substrate cultivation techniques are relatively easy to master [2]. In recent years, due to the increasing demand for cultivation substrates, it has a very good market prospect. As a medium for the growth of crops, the substrate must provide a good water, gas and fertilizer environment for the growth of the crop's rhizosphere, and should have the functions of supporting and fixing plants, supplying water, nutrients and oxygen, and ensuring rhizosphere gas exchange [3]. Due to the different properties of different types of substrates, the selection of substrates should be based on the specific characteristics of different crops.

2. Materials and methods
The test substrates were perlite, vermiculite, coconut bran, and grass charcoal.

The test crop was Italian lettuce.

When lettuce seedlings grow 4-6 true leaves, they are planted in a nutrient bowl. The ratio of the substrate in the nutrient bowl is shown in Table 1. Each treatment is set up to repeat the test three times. The plant height, chlorophyll content, and soluble sugar content of lettuce were measured on the 7th, 14th, 21st and 28th days after planting.
Table 1. Matrix formulas with different ratios

| group | Perlite | Peat | Coconut Peat | Vermiculite |
|-------|---------|------|--------------|-------------|
| T1    | 1       | 7    | 1            | 1           |
| T2    | 1       | 6    | 2            | 1           |
| T3    | 1       | 5    | 3            | 1           |
| T4    | 1       | 4    | 4            | 1           |
| T5    | 1       | 3    | 5            | 1           |
| T6    | 1       | 2    | 6            | 1           |
| T7    | 1       | 1    | 7            | 1           |

3. Results and Analysis

3.1. The effect of different substrate ratios on lettuce plant height

As shown in Table 2, on the 7th day after planting, there was no significant difference among the treatments. The order of plant height from high to low was T4>T6>T5>T7>T3>T2>T1.

On the 14th day after planting, the order of plant height was T5>T4>T6>T3>T2>T7>T1. T5 treatment and T1, T7 all reached a very significant level of difference, T5 treatment and T2, T3 treatment reached a significant level of difference. The plant height of the low peat treatment was greater than that of the high peat treatment, and the plant height of the high coco peat treatment was greater than that of the low coco peat treatment.

On the 21st day after planting, the order of plant height was T5>T6>T4>T3>T7>T2>T1. T5 treatment and T1, T2, T3, T7 treatment reached a very significant difference level, T6 treatment and T7, T2, T1 reached a very significant difference level, T4 treatment and T1, T2 reached a very significant difference level, T3 and T6, T4 reached the level of significant difference, and T7 and T4 reached the level of extremely significant difference. The plant height of the low peat treatment was significantly greater than that of the high peat treatment. The plant height of the high coco peat treatment was significantly greater than that of the low coco peat treatment. The plant height of lettuce increased with the increase of the coco peat ratio in the substrate. With the decrease of the ratio of peat charcoal, the plant height starts to decrease when the proportion of peat charcoal decreases. When it is increased to T5, the plant height reaches the maximum value.

On the 28th day after planting, the lettuce has reached maturity, the plant height of each treatment group is ranked as T5>T6>T4>T3>T7>T2>T1. T1 treatment and T4, T5, T6, T7 treatment reached extremely significant. The difference level, T2 treatment and T5 reached a very significant difference level, T3 treatment and T5 reached a very significant difference level, T5 and T7, T4 reached a significant difference level, T1 and T3 reached a significant difference level. The plant height of the low peat treatment was greater than that of the high peat treatment, the plant height of the high coco peat treatment was greater than that of the low coco peat treatment, and the plant height of lettuce increased with the increase of the coco peat ratio in the substrate. When the proportion of peat charcoal decreases, the plant height reaches the maximum when it is increased to T5, and when the proportion of coconut bran continues to increase, the plant height begins to decrease.

The overall plant height of lettuce showed an upward trend during the growth period. During the colonization period, from the 7th day there is no significant difference between the groups, to the 14th, 21st, and 28th day of the colonization, the T5 treatment showed a significant or extremely significant difference from other formulas, which can clearly show T5. Treatment plant height advantage. It can be seen from the data that after the 14th day of planting, the plant height of T5 treated lettuce is always greater than that of other formula lettuce. On the 28th day after planting (mature period), the plant height of T5 treated lettuce is 24.95 cm, which is The best growing group of all the ratios.
Table 2. The effect of different substrate ratios on lettuce plant height (cm)

| group | 7d   | 14d   | 21d   | 28d   |
|-------|------|-------|-------|-------|
| T1    | 5.73Aa | 7.92Bb | 13.60Cc | 20.24Cc |
| T2    | 5.86Aa | 8.60ABb | 15.10Cbc | 21.95BCbc |
| T3    | 6.36Aa | 8.68ABb | 15.73BCb | 22.36BCb |
| T4    | 6.70Aa | 9.19ABab | 17.85ABa | 22.74ABab |
| T5    | 6.47Aa | 10.90Aa | 18.37Aa | 24.95Aa |
| T6    | 6.68Aa | 9.18ABab | 18.11ABa | 23.54ABab |
| T7    | 6.38Aa | 8.43Bb | 15.67Cb | 22.77ABb |

Note: The uppercase letters represent the extremely significant difference level when ≤0.01, and the lowercase letters represent the significant difference level when ≤0.05, the same below.

3.2. Effect of Different Substrate Proportions on Chlorophyll Content of Lettuce

As shown in Table 3, on the 7th day after planting, the order of the chlorophyll content of each ratio was T6>T5>T4>T7>T3>T2>T1, and there was no significant difference between the treatments.

On the 14th day after planting, the chlorophyll sequence of each substrate ratio was T4>T5>T6>T7>T2>T3>T1, and there was no significant difference between the treatments. The chlorophyll content of the low peat treatment was higher than that of the high peat treatment, the chlorophyll content of the high coco peat treatment was higher than that of the low coco peat treatment, and the chlorophyll content of lettuce increased with the increase of the proportion of coconut peat in the substrate. As the proportion of peat decreases, when the content increases to T4 treatment, the maximum chlorophyll content is reached, and when the proportion of coconut bran continues to increase (decrease the proportion of peat), the chlorophyll content begins to decrease.

On the 21st day after planting, the order of chlorophyll for each substrate ratio was T5>T4>T3>T6>T7>T1>T2, T5 treatment and T2, T1 treatment reached a very significant level of difference, T5 treatment and T3, T6, T7 treatment reached the level of significant difference. The chlorophyll content of the low peat treatment was higher than that of the high peat treatment, the chlorophyll content of the high coco peat treatment was higher than that of the low coco peat treatment, and the chlorophyll content of lettuce increased with the increase of the proportion of coconut peat in the substrate. As the proportion of peat decreases, the chlorophyll content reaches the maximum when it is increased to T5 treatment, and when the proportion of coconut bran continues to increase (decrease the proportion of peat), the chlorophyll content begins to decrease.

On the 28th day after planting, the order of chlorophyll for each substrate ratio was T5>T7>T4>T3>T6>T2>T1, T5 treatment and T2, T6, T1 treatment reached a very significant level of difference, T1 treatment and T7 treatment reached a very significant level of difference, T5 treatment and T3, T4 treatment reached a significant difference level, T2 treatment and T7 treatment reached a significant difference level, T1 treatment and T4 treatment reached a significant difference level. The chlorophyll content of the low peat treatment was higher than that of the high peat treatment, the chlorophyll content of the high coco peat treatment was higher than that of the low coco peat treatment, and the chlorophyll content of lettuce increased with the increase of the proportion of coconut peat in the substrate. As the proportion of peat decreases, it reaches the maximum chlorophyll content when it is increased to T5 treatment, and when the proportion of coconut bran continues to increase (decrease the proportion of peat), the chlorophyll content begins to decrease.

The chlorophyll content of lettuce showed an upward trend throughout the whole planting period. During the colonization period, from the 7th and 14th days after the colonization, there was no significant difference between the groups, to the 21st and 28th days after the colonization, the T5 treatment showed a significant or extremely significant difference from other formulas, which can clearly show. The chlorophyll content advantage of T5 treatment is shown. After 21 days of planting,
the chlorophyll content of lettuce treated with T5 was higher than other treatments. On the 28th day after planting (mature period), the chlorophyll content of lettuce treated with T5 was 0.676 mg/g, which was the highest chlorophyll content of all the ratios.

Table 3. Effect of Different Substrate Proportions on Chlorophyll Content of Lettuce. (mg/g)

| group | 7d    | 14d   | 21d   | 28d   |
|-------|-------|-------|-------|-------|
| T1    | 0.104Aa | 0.183Aa | 0.278Bb | 0.496Cd |
| T2    | 0.112Aa | 0.198Aa | 0.276Bb | 0.528BCcd |
| T3    | 0.117Aa | 0.197Aa | 0.322ABb | 0.563ABCbcd |
| T4    | 0.128Aa | 0.236Aa | 0.354ABab | 0.586ABCbc |
| T5    | 0.158Aa | 0.234Aa | 0.415Aa | 0.676Aa |
| T6    | 0.164Aa | 0.227Aa | 0.318ABb | 0.543BCbcd |
| T7    | 0.124Aa | 0.225Aa | 0.304ABb | 0.623ABab |

3.3. The influence of different matrix ratios on the content of soluble sugar

As shown in Table 4, on the 7th day after planting, the order of the soluble sugar content of each ratio was T4>T5>T3>T6>T2>T7>T1. T1 treatment and T4, T5 treatment reached a very significant level of difference, T4 treatment and T3, T6, T2, T7 treatment reached a significant difference level, T5 treatment and T7 treatment reached a significant difference level. The soluble sugar content of lettuce increases with the increase of the proportion of coconut bran in the substrate, and decreases with the decrease of the proportion of peat. When it is increased to T4 treatment, it reaches the maximum soluble sugar content, and then continues to increase the proportion of coconut bran (Reduce the proportion of peat), the soluble sugar content begins to decrease.

On the 14th day after planting, the order was T5>T4>T3>T6>T1>T7>T2, T2 treatment and T4, T5 treatment reached a very significant level of difference, T5 treatment and T7, T1 treatment reached a significant difference level, T4 treatment and T7 treatment reached a significant difference level, T3 treatment and T2 treatment reached a significant difference level. The soluble sugar content of lettuce increases with the increase of the proportion of coconut bran in the substrate, and decreases with the decrease of the proportion of peat. When it is increased to T5 treatment, it reaches the maximum soluble sugar content, and then continues to increase the proportion of coconut bran (Reduce the proportion of peat), the soluble sugar content begins to decrease.

On the 21st day after planting, the order of soluble sugar content was T5>T4>T3>T6>T7>T2>T1, and T1 treatment and T4, T5 treatment reached a significant level of difference. The soluble sugar content of lettuce increases with the increase of the proportion of coconut bran in the substrate, and decreases with the decrease of the proportion of peat. When it is increased to T5 treatment, it reaches the maximum soluble sugar content, and then continues to increase the proportion of coconut bran (Reduce the proportion of peat), the soluble sugar content begins to decrease.

On the 28th day after planting, the soluble sugar content of each treatment group was ranked as T4>T5>T3>T6>T7>T2>T1. T1 treatment and T3, T4, T5, T6, T7 treatment reached extremely significant levels of difference, T2 treatment and T3, T4, T5, T6, T7 treatment reached extremely significant difference level, T4 treatment and T6, T7 treatment reached significant difference level. The soluble sugar content of low peat treatment was slightly higher than that of high peat treatment, and the soluble sugar content of high coco peat treatment was slightly higher than that of low coco peat treatment, and the soluble sugar content of lettuce increased with the coconut in the matrix. The proportion of bran increases and decreases as the proportion of peat decreases. When it is increased to the T4 treatment, the maximum soluble sugar content is reached. When the proportion of coconut bran continues to increase (decrease the proportion of peat), the soluble sugar content begins to decrease.

The soluble sugar content of lettuce showed an upward trend during the growth period. From the 7th day of planting, T4 treatment and T5 treatment always showed a significant or extremely significant difference from other formulas, which can clearly show the soluble sugar content advantage of T4 and
T5 treatment. After 7 days of planting, the soluble sugar content of lettuce treated with T4 and T5 was always higher than that of other treatments. On the 28th day after planting (maturation period), the soluble sugar content of lettuce treated with T4 was 5.834 mg/g, which was soluble in all ratios. The group with the highest sugar content.

| Table 4. The effect of different matrix ratios on the soluble sugar content of lettuce (mg/g) |
|-----------------------------------------------|
| group | 7d       | 14d      | 21d       | 28d       |
|-------|----------|----------|-----------|-----------|
| T1    | 0.543Bc  | 2.173ABbcd | 2.842Ab  | 5.314Bc  |
| T2    | 0.643ABc | 2.048Bd  | 2.948Aab  | 5.324Bc  |
| T3    | 0.667ABbc | 2.231ABabc | 3.014Aab | 5.743Aab |
| T4    | 0.887Aa  | 2.324Aab  | 3.012Aa  | 5.834Aa  |
| T5    | 0.796Aab | 2.364Aa  | 3.03Aa  | 5.801Aab |
| T6    | 0.647ABbc | 2.196ABabcd | 3.009Aab | 5.643Aab |
| T7    | 0.632ABc  | 2.116ABced | 2.988Aab | 5.631Ab |

4. Conclusion
In this experiment, the plant height, chlorophyll content, and soluble sugar content of lettuce were measured. The test results showed that with the increase of coconut bran in the substrate ratio, the plant height, chlorophyll and soluble sugar content of lettuce continued to increase until a certain ratio was reached. After reaching the maximum value, continue to increase the proportion of coconut bran, and these indicators begin to decrease. The plant height and chlorophyll content of T5 treatment are the highest, and the soluble sugar content of T4 treatment is the highest.

The comprehensive measurement results concluded that T5=Perlite: Peat: Coconut Peat: Vermiculite=1:3:5:1 is the most suitable ratio for lettuce growth among the 7 groups of substrates in this experiment. This conclusion can guide the soilless cultivation of lettuce.

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