The Study on Screening of Rosa Cultivation Substrate of Vertical Greening Plant

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Abstract: The bulk density of the four cultivated substrates prepared in the experiment varied between 0.42 and 0.57 g/cm^3, they all belong to light cultivation substrate. The pH was between 7.38 and 7.95, when the peat: wormcast: vermiculite: mushroom dreg fertilizer was 0.5:0.5:2:1, it is the lowest and neutral, and the CE value satisfied the requirements of plant cultivation. In 4 kinds of cultivation substrates, the contents of total and available nitrogen, phosphorus and potassium were abundant, and the contents of organic matter were high. When the peat: wormcast: vermiculite: mushroom dreg fertilizer was0.5:0.5:2:1, the rosa plant height is the highest, there was no significant difference in the content of nitrogen and chlorophyll in the leaves of rosa. According to the comprehensive indexes, the cultivation substrate of peat: wormcast: vermiculite: mushroom dreg fertilizer of 0.5:0.5:2:1 is most suitable for the growth of rosa.

1. Introduction

Along with the people in the pursuit of a better life, vertical greening cultivation technology begins to be widely used, it covers a small area, good greening effect, can obviously alleviate the heat island effect and improving the city's green coverage rate greatly. Vertical greening is a complex systems project, different from surface greening, it must not only satisfy the growth needs of the plant, but also needs to take full account of the building load capacity, safety and feasibility of operation and maintenance. Therefore, light substrate becomes the focal point of research and development. In vertical greening, the cultivation substrate can fix plants, retain moisture, root ventilation and provide partial nutrition, it can provide plant roots with good water, gas, fertilizer, heat, pH and other living conditions. The vertical greening cultivation needs to solve the important question, also one of the key links of the vertical greening is how to choose a good substrate, so that it not only satisfy the needs of plant growth, but also effectively reduce the load. The organic matter in the cultivation substrates can provide sufficient nutrients for plant growth, the organic substrate with the most demand and the best application effect is peat, however, excessive peat extraction can be damaging to the environment, which is not the content of green development. In recent years, the organic waste as a new substrate for horticultural cultivation is developed, it has become a research hotspot, among them, bark, crop straw and animal waste have been used as the substrate for new horticultural cultivation, the development and application of new horticultural cultivation substrate can solves the problem of insufficient cultivation substrate resources, in addition, it has wide sources, low price, and can turn waste into treasure, realize resource reuse[1-2].Edible mushrooms industry development in China in recent years very rapidly, which result in a large number of mushroom dreg. The mushroom dreg is a good choice of substrate because of its light weight and rich nutrition, however, its nutritional composition is complex, if it is directly used as substrate may cause low germination rate, yellow plants, weak growth and other problems, so only after high temperature rotten, it can be used as cultivation matrix[3].In addition, studies have shown that mixed matrix is better than single matrix, the mixture of organic and inorganic matrix is better than

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pure organic matrix or pure inorganic matrix[4].Hence, this experiment mixed the mushroom dreg with peat, vermiculite and organic fertilizer (wormcast), determined the mixed matrix's physical and chemical properties, and associated with plant growth features, understand the characteristics of the mixed matrix, it provides a new way for the research of new soilless cultivation substrate.

Because of the variable appearance of the vine climbing plant, at the same time, leaf transpiration and shade effect can make metope temperature greatly reduced in summer, it is the inevitable trend of urban greening development [5]. Rosa is a general term for part of the genus rosa plants, it likes light, and can tolerate half shade, cold, dry conditions, the requirement of soil condition is not strictly, but it grows better in soil that is deep, loose, fertile moist and smooth drainage. This experiment through outdoor pot experiments, studied the growth and physiological indexes of rosa in the preparation of different vertical green substrate cultivation, combined with the rosas' growth, pick out the most suitable vertical greening cultivation matrix to provide reference for vertical greening.

2. Materials and Methods

2.1 Experimental Materials.

The experimental plant was rosa, the seedlings were purchased on Tmall net, without disease and insect pests, and the plant height was about 8 cm. The light cultivation substrate materials were wormcast, peat, mushroom dreg fertilizer, vermiculite and polyacrylamide.

2.2 Experimental Method.

The experiment was carried out in shuigaozhuang village, xinkou town, xiqing district, Tianjin, using outdoor pot experiments, 4 different substrate mix treatments were set up (see table 1),repeat each treatment 3 times, the determination methods of substrate nutrients in cultivation were shown in table 2.On May 12, 2018, the mixed substrates placed in flowerpots with a diameter of 44cm and a height of 28cm, to transplant 4 rosa seedlings evenly in each pot and water them thoroughly, to place them outside. Chlorophyll and nitrogen contents in the middle and upper part of rosa leaves were measured by TYS-3N plant nutrition analyzer in the morning respectively, and the plant height of above-ground part of rosa was measured with tape ruler, the measured dates are June 26, July 7, July 15, July 31, August 26, September 22 and October 9, 2018.

Table 1 The volume ratio of peat, wormcast, vermiculite, and mushroom dreg fertilizer

Treatment	Peat: Wormcast; Vermiculite:Mushroom dreg fertilizer
J1	0.5:0.5:1:1
J2	1:1:1:1
J3	0.5:0.5 :1 :2
J4	0.5 :0.5 :2 :1

Table 2 Method for determining soil physical and chemical properties

Soil properties	Test methods
Organic matter	Chulin method
Total nitrogen	Concentrated sulfuric acid, Semi-micro-Kelvin method
Total phosphorus	Sodium hydroxide melting, Molybdenum antimony, Spectrophotometer
Total potassium	Nitric acid and perchloric acid digestion, Flame photometer or atomic absorption spectrometry
Alkaline nitrogen	Alkaline solution diffusion method
Available phosphorus	Sodium carbonate extraction, Molybdenum antimony, Spectrophotometer
Available potassium	Sodium acetate extraction,Flame photometer
Bulk weight	Ring knife method
pH	Water extraction, Acidity meter
EC	Water extraction, Conductivity meter

2.3 Statistical Analysis.

Microsoft Excel (Office 2007) was used to make charts and SPSS was used to process data.

3. Results and Analysis

3.1 Physical and Chemical Properties and Nutrient Content of Different Cultivation Substrate. Compare the Physical Parameters of Different Cultivation Substrate.

In the cultivation substrate, pH value, organic matter and content of various nutrients are important physical and chemical properties, they will affect the effect of plant cultivation directly, but there was no cultivation matrix standardized character parameters has been proposed yet[6].From table 3, the bulk density of the four vertical planting substrates varied between 0.42-0.57 g/cm3,they were all satisfied the ideal matrix 0.1-0.8 g/cm3 bulk density range[7], belong to light matrix. The order of different treatments matrix bulk density was J2>J4>J3>J1;the value of saturated moisture content represents the water holding capacity of the matrix, the order of saturated water content of the four treatments was J4>J3>J1>J2,itindicated that in terms of water holding capacity, J4 was the best, J2 was the worst, Nutrients and water are transported to the root system through capillary pores in the matrix, the order of capillary porosity of the four substrates was J4 > J3> J2> J1;Total porosity was J4>J2>J3>J1,within 54%-96% of the total porosity of the ideal matrix[7].

Table 3 Physical indexes of different cultivation substrate

Treatment	Bulk density [g/cm^3]	Saturated moisture content [%]	Capillary Porosity [%]	Total porosity [%]
J1	0.42	158.12	41.15	66.68
J2	0.57	127.46	62.95	72.10
J3	0.45	160.50	63.90	71.38
J4	0.49	169.33	65.74	72.37

3.2 Compare the Chemical Indexes of Different Cultivation Substrate.

In general, suitable pH should be stable, and should be neutral or weak acid[8].From table 4,the pH of the four vertical afforestation matrix varied between 7.38 and 7.95,J2 was the highest, J4 was the lowest, J3 and J4 were neutral, J1 and J2 were weakly basic. In the matrix, the EC value represents the concentration of salts, it reflects the value of soluble salt. Generally, when the EC value exceeds 1.25 mS/cm, the salt needs to be washed[7], prevent it from causing osmotic stress to plant roots. In this experiment, the EC value used varied between 698-1169μs/cm, so it didn't have to be washed.

Table 4 Chemical indexes of different cultivation substrate

Treatment	pH	EC[μs/cm]
J1	7.91	689.5
J2	7.95	698
J3	7.43	1169
J4	7.38	896

3.3 The Nutrient Content of Different Cultivation Substrate.

From table 5,in the four kinds of cultivation substrate, the contents of total and available nitrogen, phosphorus, potassium and organic matter were very high, they all have a large capacity and intensity of fertilizer supply could provide sufficient nutrients for plants.

Table 5 Nutrient content of different cultivation substrate

Treatment	Total nitrogen [g/kg]	Nitrate nitrogen [mg/kg]	Total phosphorus [g/kg]	Effective phosphorus [mg/kg]	Total potassium [g/kg]	Effective potassium [mg/kg]	Organic matter [g/kg]
J1	10.81	77.39	1.49	109.87	9.52	2690.17	149.63
J2	11.85	83.97	2.94	111.31	7.21	2890.95	181.15
J3	13.36	83.91	2.85	106.11	6.45	3250.28	178.16
J4	11.72	76.24	1.88	108.18	8.24	3604.11	163.69

3.4 Rosa Plant Height in Different Cultivation Substrate.

From figure 1, rosa grows differently in different vertical afforestation matrix, there was no significant difference in plant height on July 7, July 15 and August 26; on June 26,the plant height of J4 rosa was significantly higher than that of J3,and there was no difference between J1 and J2,on July 31, the matrix of J4 was significantly higher than that of J1, with no significant difference from that of J2 and J3; on September 22 and October 9, J4 was significantly higher than other cultivation substrates, and the difference between the other three substrates were not significant. From figure 1, on June 26, rosa plant height was highest in J4 matrix (30.33cm) and lowest in J3 matrix (22.00cm). From June 26 to October 9, rosa in J1 matrix increased from 27.33 cm to 51.33 cm, rosa in J2 matrix increased from 27.67 cm to 45.00 cm, rosa in J3 matrix increased from 22.00 cm to 51.00 cm, rosa in J4 matrix increased from 30.33 cm to 87.33 cm, it could be seen that the growth of the J4 effect was more obvious.

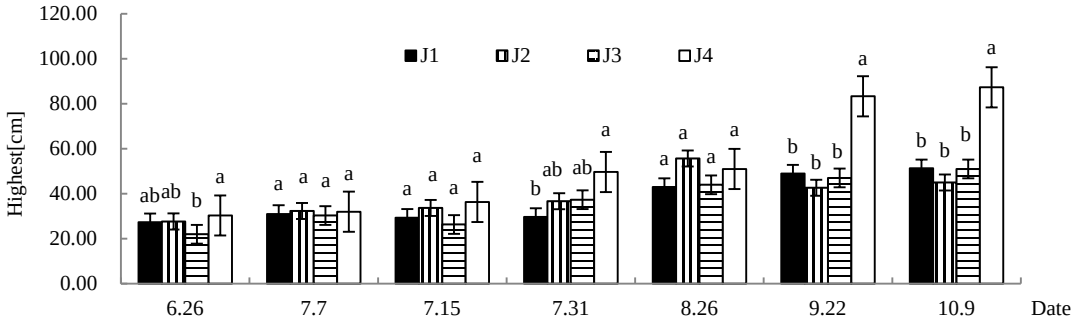

Fig. 1 Variation of rosa plant height with determination time

Note: Different small letters indicate significant difference at 0.05 level. The same as follows.

3.5 Changes of Chlorophyll Content in Rosa Leaves in Different Cultivation Substrate.

Chlorophyll is the main pigment for photosynthesis in plants. When it is high, that means plants have strong photosynthesis and accumulate more organic dry matter, keep plants leaf color thick, biomass and more flourishing. From figure 2, the variation of chlorophyll content in rosa leaves during different determination periods was between 40.40-54.30of J1,J2 was between 38.10-48.77,J3 was between 43.00-52.03 and the J4 was between 37.00-51.33.At each determination date, there was no significant difference in chlorophyll content between different vertical afforestation matrix.

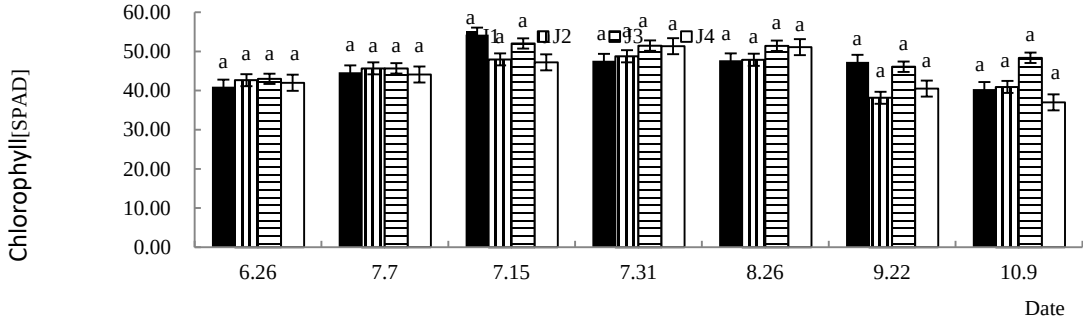

Fig.2 Variation of rosa plant chlorophyll content with determination time

3.6 Changes of Nitrogen Content in Rosa Leaves in Different Cultivation Substrate.

Nitrogen is the main component of protein, enzyme, chlorophyll, nucleic acid and auxin, it is closely related to cell proliferation, plant growth and development. From Fig.3, the variation of nitrogen content in rosa leaves during different treatments were as follows: J1 was between 3.40-4.37 mg/kg, J2 was between 4.07-4.43 mg/kg, J3 was between 3.53-4.20 mg/kg, and J4 was between 3.50-4.33 mg/kg. At each determination date, there was no significant difference in nitrogen content between different cultivation substrate.

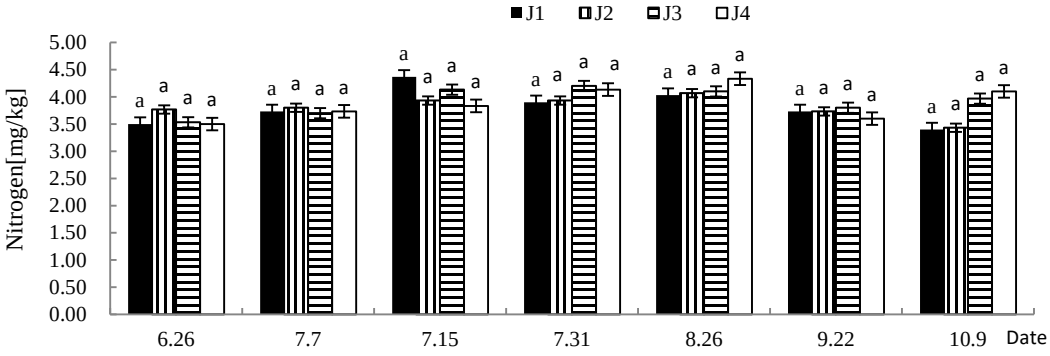

Fig. 3 Variation of rosa plant nitrogen content with determination time

4. Conclusion and Discussion

Different substrates can provide different amounts of nutrients, in this experiment, four basic matter (peat, wormcast, vermiculite, mushroom dreg fertilizer) were used. Vermiculite contains nutrients such as potassium, calcium and magnesium, water retention capability is strong, it also improves the aeration of the substrate. As a kind of organic waste, mushroom dreg fertilizer can not only increase the content of nutrients in soil, but also be used as a substrate of organic waste. In this experiment, four kinds of vertical green cultivation substrates prepared, nutrient content was very rich, rosa could grow well, the chlorophyll content and nitrogen content in the leaves of rosa were both higher, which were beneficial to the increase of organic matter in photosynthesis. From other aspects, when the volume ratio of peat: wormcast: vermiculite: mushroom dreg fertilizer was 0.5:0.5:2:1 (J4), the effect of high growth was obvious. The ideal substrate for growing rosa should have strong water and fertility retention, strong air permeability, suitable acidity and alkalinity, and strong supporting effect. The J4 matrix selected in this experiment was a mixed matrix, its acid base and EC were suitable, could provide sufficient organic matter, nitrogen, phosphorus, potassium and other nutrients, it can satisfy the nutritional needs of rosas throughout their life, and the four basic substrates included in the J4 matrix were inexpensive and readily available. In conclusion, J4 substrate could be selected as cultivation substrate for rosa.

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