Formula Experiment of Vegetable Crops

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Abstract: Five kinds of tomato cultivation substrates (AT1, AT2, AT3, AT4 and AT5) were designed with rotten cow dung, corn stalk, rice husk and slag as the main raw materials, and the conventional facility soil as the control (CK), through microbial fermentation, the target yield method was applied to different substrates. Comparative experiments were conducted. The purpose of this study was to improve the safe production of greenhouse vegetables, improve the ecological recycling and efficient utilization of agricultural organic wastes, effectively reduce the cost of cultivation media, improve the quality and yield of tomato fruits, and select the best treatment for tomato growth. The results showed that the growth effect of AT2 and AT3 was the best after synthesizing the growth potential, root system, yield and quality of tomato. Applying AT2 and AT3 matrix formula to cultivate tomato can achieve the effect of whole season free dressing.

1. Introduction

With the development of facility horticulture, modern agricultural production has become more and more specialized, intensive and large-scale, aggravating the occurrence of continuous cropping obstacles, and unscientific use of chemical fertilizers, pesticides and so on, limiting the sustainable development of agriculture and food safety in China. Soilless cultivation is one of the important means to solve the above problems. Because the traditional soilless cultivation technology has the shortcomings of high equipment investment, complex technical system and low quality of labor force involved in agriculture, it is difficult to popularize this technology in China.

It is an effective way to popularize facility agriculture to study a soilless cultivation technique with low equipment input and relatively simple technology. In order to popularize soilless cultivation better, the proposal of organic ecotype soilless cultivation has played a vital role. Organic ecotype soilless cultivation is a new type of green soilless cultivation technology, which is not cultivated in soil, but uses the substrate mainly composed of organic materials, and uses organic solid fertilizer instead of traditional nutrient solution to irrigate plant roots, and directly uses clean water to irrigate. Organic eco-soilless cultivation can improve the yield and quality of horticultural crops, reduce the use of chemical fertilizers and pesticides, ensure the cleanliness and hygiene of products, save water and fertilizer, save labor, and also produce horticultural crops on non-arable land [2]. At the same time, it can simplify the complicated management and operation mode of soilless cultivation. On this basis, if the cultivation substrate can be fully nutriented, it will greatly accelerate the popularization and application of the technical measures.

Heilongjiang Province is a big agricultural province. According to incomplete statistics, the total amount of straw that can be collected and utilized in Heilongjiang Province is more than 5 million tons every year, but its actual usage and interest are less than 20 million tons, and the total amount of farming wastes is as high as 300 million tons. Thus, the space of agricultural organic wastes recycling in Heilongjiang Province is huge. Big. However, more than 60% of them are directly incinerated by farmers, and livestock manure is directly applied to farmland without treatment, which is not only a waste of resources but also a damage to the environment [3]. These wastes are rich in nutrients needed for the growth and development of plants. Research reports have shown that

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the treatment of agricultural organic wastes by microorganisms can not only recycle wastes, but also protect the environment and promote the sustainable development of agricultural and forestry industries [4]. It is of great significance to ensure the safety and sustainable production of green food and vegetable by reasonable and scientific compounding and applying it to soilless cultivation substrate. Therefore, it is of great significance to combine the rich agricultural organic wastes and organic ecological cultivation substrates in Heilongjiang to promote the sustainable development of agriculture.

Tomato (Solanum lycopersicum) is one of the largest cultivated fruits and vegetables in the world and China because of its rich nutrition. With the improvement of people's living standard, the demand for tomatoes is also increasing. Due to the drive of economic interests and the limitation of knowledge level, there are serious problems in tomato production, such as excessive application of chemical fertilizers, which threaten people's health and ecological environment [5]. Therefore, the use of organic eco-type total nutrient cultivation substrate to produce tomatoes, improve the yield of tomatoes at the same time to ensure food safety issues, for large-scale cultivation of tomatoes to provide favorable conditions [6].

In response to the national policy of reducing weight and medicines, an organic and ecological total nutrient soilless cultivation substrate formula, which can be used in the production of protected vegetables and is characterized by no or less topdressing, will be developed to greatly reduce the production process of protected vegetables. It is significant to reduce the amount of chemical fertilizer in the process of vegetable production. [7] The results of this study can provide a more convenient and easy-to-grasp cultivation model for organic ecotype soilless cultivation technology, which can better promote the efficient and high-quality production of Protected Horticultural crops, reduce the cost of soilless cultivation, save land and reduce labor force, thereby improving economic and ecological benefits [8].

2. Materials and methods

2.1 Test materials

The variety of Solanum lycopersicum was provided by Tianjin Kerunjin Fengxue Seed Industry Co., Ltd.

Substrate materials: crushed corn stalk, rotten cow dung, rice husk and slag are provided by Shuangcheng Dasheng Chemical Co., Ltd. and earthworm dung is provided by Shenyang Zunlong Biotechnology Co., Ltd.

Fertilizer for test: Urea is supplied by CPC Petroleum and Natural Gas Co., Ltd. and potassium sulfate is supplied by Xinjiang Lop Nur Potassium Salt Co., Ltd.

Auxiliary material: crosslinked polyacrylamide (CP), provided by Beijing Han Li Bao Technology and Trade Center.

2.2 Test method

The experiment was conducted in the Laboratory of Physiology and Ecology of Facilities Vegetables, Greenhouse and College of Horticulture and Landscape Architecture of Northeast Agricultural University from August 2017 to March 2018. The self-made simple organic substrate soilless cultivation tank was used in the experiment. The net width of the tank was 48 cm, the net height of the tank was 20 cm, and the net length of the tank was 480 cm. The bottom of the groove is covered with a plastic film to store water and prevent leakage. The groove spacing is 50cm. The groove is covered with plastic film after the substrate is installed.

Corn stalk, rotten cow dung, rice husk and slag were used as raw materials. On the basis of previous experiments, the basic materials suitable for tomato cultivation were prepared by Shuangcheng Dasheng Chemical Co. Ltd. A was the basic material for organic ecological cultivation of tomato: (quick-acting N: 15.14 g/kg; quick-acting P: 0.79 g/kg; quick-acting K Water-soluble Ca: 1.19 g/kg, water-soluble Mg: 8.56 g/kg, adding different matrix materials and fertilizers to the basic materials.

Tomato cultivation matrix formula material:

Formula and numbered basic material formulation (volume ratio) is allocated to chemical fertilizer quantity (g/L).

Masterbatch A: earthworm dung urea potassium sulfate

AT1 101.7 3.5

AT2 31 - -

AT3 311.475 0.67

AT4 21 - -

AT5 211.4 0.88

CK common soil

Fertilizer Addition = [Tomato Target Yield Fertilizer Requirement [9] - Nutrients in Organic Ecotype Soilless Culture Substrate]/ Nutrient Absorption Rate in Fertilizer.

Organic ecological total nutrient cultivation substrate was compounded according to the method of Table 1-1 and then filled in the substrate cultivation tank for use. When tomato seedlings were 7-8 leaves and 1 heart, seedlings with the same growth were selected and planted in the cultivation tank. The tomato plant spacing is 0.24M, and the plant spacing is 0.32m, which is equivalent to 3000 seedlings per 667. All cultivation tanks were irrigated with drop arrow system except CK treatment. The tomato was irrigated with clear water only during the whole experiment period. The tomato was treated with CK, diamine 30kg/667m2, potassium sulfate 15kg/667m2, and topdressing in the middle period. The physical and chemical properties, plant growth and physiological indicators were determined, and the yield was measured, and the quality was analyzed in the middle stage of the fruit.

Item determination

Determination of tomato growth index

Plant height, stem diameter, leaf number and plant width were measured by conventional methods; leaf gas exchange parameters were measured by LI-6400 photometer; root activity was measured by TTC method [10]; root volume was measured by water substitution method [11].

Determination of tomato fruit quality

The content of soluble sugar and total sugar was determined by the anthrone method of Gao Junfeng [12]. The ratio of sugar to acid was equal to the content of soluble sugar/organic acid.

Determination of physical and chemical properties of matrix

PH value and EC value were determined by acidity meter and conductivity meter according to the leaching method of water-soil ratio 5:1 respectively; available nitrogen content was determined by alkaline hydrolysis-diffusion-volumetric method; available phosphorus content was determined by M3 leaching-molybdenum-antimony colorimetric method; available potassium content was determined by M3 leaching-flame photometry; organic matter content was determined. The content was determined by sulfuric acid-potassium dichromate oxidation-volumetric method, and the conductivity of soil leaching solution EC (ds/m) was determined by water extraction (water: soil = 5:1) - conductivity method.

Determination of soil bulk density and porosity: Take a container with known volume (V) and weigh it as W1. Then add different air-dried substrates into the container and weigh it as W2. Seal the container with two layers of gauze and immerse it in water for 24 hours. Remove the gauze and weigh it according to the following formula: 3) = (W2 W1) / V; total porosity (%) = (W3 W2) / V * 100%[13].

2.3 Data analysis

The original data measured in the test were processed by Microsoft Excel (Office 2003) software and SAS 9.1 software.

3. Results and analysis

In the first 30 days after tomato planting, the content of available nitrogen in different formulations of tomato substrate was stable, and there was no significant change. After 30 days of tomato planting, the content of available nitrogen in different formulations of tomato substrate increased compared with the first 30 days after planting. The content of available nitrogen in CK and AT3 treatments was higher than that in AT1, AT2 and AT4 treatments on the 10th day after tomato planting. On the 20th day after planting, the content of available nitrogen in AT3 treatment was the highest, but there was no significant difference between AT3 treatment and other treatments ($p < 0.05$). The content of available nitrogen in CK treatment was significantly lower than that in 10th day after planting. After tomato colonizationFig. 2-5 changes of EC content in tomato matrix with different formula

Changes of physical properties of tomato cultivated substrates with different 2.1.3 formulations

The bulk density of all treatments had little fluctuation and little change during the whole growth cycle of tomato. The bulk density of CK treatment was maintained in the range of 1.0-1.2 g/cm 3 and was significantly higher than that of other treatments. The bulk density of other treatments ranged from 0.3 to 0.8/cm 3, which accorded with the standard of high quality substrate. Yes. The total porosity of tomato culture substrates fluctuated obviously during the whole growth period of tomato. With the increase of planting days, the total porosity of each treatment also changed. Among them, the total porosity of CK treatment was relatively stable in the whole growth cycle of tomato, AT1 treatment showed a general trend of first decline and then increase, AT2 and AT3 treatment showed an overall upward trend, AT4 and AT5 treatment showed a general trend of first increase and then decline.

The effects of different matrix treatments on the plant height of tomato plants were obvious. On the 10th day after tomato planting, the tomato plants treated with AT2 were the highest, and the tomato plants treated with AT5 were the lowest, and there was significant difference between the two treatments ($p < 0.05$). On the 20th day after tomato planting, the plant height of each treatment was the same as that of the 10th day. In the 10th day, the plant height of CK treatment was the highest, and that of AT2 treatment was the lowest. On the 30th day after planting, the plant height of each treatment was the same as that of the previous two sampling. Among them, the growth of plant height of AT4 treatment was the highest, and that of AT3 treatment was the lowest. On the 40th day after tomato planting, the plant height of AT2 treatment was the highest, the plant height of AT1 treatment was the lowest, and there was no significant difference among treatments. Among them, the plant height of AT5 treatment was the highest, and the plant height of AT1 treatment was the lowest. On the 50th day after tomato planting, the plant height of AT2 treatment was the highest, CK treatment was the lowest, and there was significant difference between the two treatments.

The effects of different matrix treatments on the stem diameter of tomato plants were obvious. On the 10th day after tomato planting, the stem diameter of AT2 treatment was the largest, and that of AT4 treatment was the smallest, and there was significant difference between the two treatments. On the 20th day after tomato planting, the stem diameter of AT1 treatment was the largest, and that of AT5 treatment was the smallest. There was no significant difference among the treatments. In the 10th day, the stem diameter of AT3 treatment increased the most, and that of AT5 treatment was the least. At the 30th day after tomato planting, the stem diameter of AT3 treatment was the largest, and that of AT5 treatment was the smallest, and the difference between them was significant. The stem diameter of AT5 treatment was significantly higher than that of CK. There was no significant difference between other treatments and CK. In the 10th day, the stem diameter of AT5 treatment increased the most, and that of AT1 treatment was the largest. The growth of stem diameter is the smallest. At the 40th day after tomato planting, the stem diameter of AT3 treatment was the largest, the stem diameter of AT5 treatment was the smallest, and there was no significant difference among the treatments. In the 10th day, the stem diameter of AT4 treatment increased the most, and the stem diameter of AT1 treatment increased the least. At the 50th day after tomato planting, the stem diameter of AT3 treatment was the largest, and that of AT1 treatment was the smallest. There was no significant difference among the treatments. In the 10th day, the stem diameter of AT5 treatment increased the most, and that of CK treatment was the smallest.

The effects of different matrix treatments on the net photosynthetic rate of tomato leaves were obvious. On the 10th day after tomato planting, the net photosynthetic rate of AT3 treatment was the highest, and that of AT4 treatment was the second. The net photosynthetic rate of CK treatment was the lowest and significantly lower than that of AT3 and AT4 treatment. There was no significant difference among other treatments ($p < 0.05$). On the 20th day after tomato planting, the net photosynthetic rate of the leaves treated with AT3 was the highest, and that of the leaves treated with AT1 was the lowest. The net photosynthetic rate of the leaves treated with AT1 was significantly lower than that treated with AT3 and AT4, but there was no significant difference among the other treatments. On the 30th day after tomato planting, the net photosynthetic rate of the leaves treated with AT1 and AT3 was the highest, while that of the leaves treated with CK was the lowest, and there was no significant difference among the other treatments. On the 40th day after tomato planting, the net photosynthetic rate of the leaves treated with AT2 was the highest, and that of the leaves treated with AT4 was the lowest, and there was a significant difference between the two treatments, but there was no significant difference among the other treatments. On the 50th day after tomato planting, the net photosynthetic rate of the leaves treated with AT4 was the highest, and that of the leaves treated with AT2 was the lowest. There was no significant difference among the other treatments. On the 60th day after tomato planting, the net photosynthetic rate of the leaves treated with AT4 was the highest, and that of the leaves treated with AT1 was the lowest, and there was a significant difference between the two, but there was no significant difference among the other treatments.

The effects of different matrix formulations on root activity of tomato plants were obvious. The root activity of AT2 and AT3 treatment was the highest, which was significantly higher than CK and other treatments ($p < 0.05$). The root activity of AT5 treatment was the lowest, but there was no significant difference between AT2 and CK.

The effect of different matrix formula on tomato plant root volume was obvious. Among them, the root volume of AT3 treatment was the largest and significantly higher than that of other treatments, and there was no significant difference among other treatments ($p < 0.05$).shows that the effect of different substrate formulations on the fruit weight of tomato is not obvious. The fruit weight of AT 1 and AT2 treatment is higher than CK treatment, and there is no significant difference among other treatments ($p < 0.05$). The fruit number of tomato plants treated with AT3 was the highest, significantly higher than that of CK and other treatments. The fruit number of tomato plants treated with AT1 was the least, significantly lower than that of CK and other treatments. Different substrate formulations had obvious effects on the early yield of tomato fruit, among which AT2 treatment had the highest yield per mu, and was significantly higher than other treatments. Different substrate formulations had significant effects on tomato fruit yield per mu, among which AT3 treatment had the highest yield per mu, and was significantly higher than other treatments.

The number of fruit per plant was /kg, the number of fruit per plant per plant was /kg, and the yield per plant was /kg

CK 0.27 + 0.01A 11.5 + 1.05b 3.12 + 0.26c 9345 + 779.02c

AT1 0.28 + 0.01A 8.67 + 1.03c 2.38 + 0.28d 7150 + 837.78d

AT2 0.29 + 0.02A 12.67 + 0.52b 3.68 + 0.18b 11040 + 539.33b

AT3 0.27 + 0.01A 17 + 0.63a 4.59 + 0.31a 13779 + 915.46a

AT4 0.27 + 0.02A 12.17 + 0.75b 3.32 + 0.23bc 9965 + 648.21bc

AT5 0.27 + 0.02A 12.17 + 1.17b 3.28 + 0.19bc 9830 + 570.68bc

Effects of different 2.2.5 substrates on tomato fruit quality can see that different matrix formula has obvious effect on the soluble sugar content of tomato fruit, among which the soluble sugar content of AT4 treatment is the highest, and that of CK treatment is the lowest, and the difference between them is significant. The sugar-acid ratio of tomato fruits treated with AT1 was the highest, and that of fruit treated with AT5 was the lowest, and the difference was significant. The total sugar content of tomato fruits treated with AT4 was the highest, while that treated with AT5 was the lowest. The total sugar content of all treatments except AT5 was higher than that of CK.

Processing number of soluble sugar content /% sugar acid ratio of total sugar /%

CK 3.35 + 0.08b 4.55 + 0.08b 4.32 + 0.05c

AT1 3.51 + 0.03b 5.27 + 0.10a 4.56 + 0.07b
AT2 3.37 + 0.02A 5.08 + 0.09ab 4.67 + 0.05b
AT3 3.67 + 0.04ab 5.27 + 0.08A 4.95 + 0.04a
AT4 3.73 + 0.02A 5.02 + 0.16ab 4.85 + 0.04a
AT5 3.62 + 0.02b 3.72 + 0.23c 4.16 + 0.11C

4. Conclusion

There have been many reports on the study of organic ecotype soilless cultivation technology in China. It is feasible to combine agricultural organic waste with solid fertilizer. However, the application of Organic Ecotype Soilless Culture in the practical application also needs [14]. In order to make plants achieve stable and high yield in the whole growth cycle without topdressing, we need to do the following: First, to ensure the continuous supply of available nutrients in the seedling substrate throughout the growth cycle. Second, nutrients should not be too high in the early stage of seedling growth, so as to ensure rapid and safe seedling retarding after planting. Third, ensure the supply of specific available nutrients at different stages of vegetable growth. At the same time, considering the differences of agricultural organic wastes between regions, this experiment selected a large number of agricultural wastes in Heilongjiang Province, and easy to collect as raw materials for the study of total nutrient organic ecotype soilless cultivation.

During the whole growth and development period of tomato, the content of available P in the substrate of tomato decreased 40 days after planting, which may be due to the higher demand for available P nutrients in the flowering stage. The content of available K in tomato substrate remained stable at the first 30 days after planting, and decreased significantly at the later stage. It was possible that tomato fruits began to form at the later stage, so the demand for available K increased greatly. This is consistent with the findings of Chai Xirong and other [15] studies. The pH value of tomato culture substrate was about 7.0, which was in the ideal range of Tomato Culture substrate; the EC value of ideal tomato culture substrate should be less than 2.50 dm.s-1[16], while the former was higher than 2.50 dm.s-1, which did not meet the requirements of high quality tomato culture substrate except AT5 treatment. The growth of tomato plants was not affected by the high EC value in the substrate, only the phenomenon of burning seedlings caused by excessive salt content in the slow seedling of AT5 treatment.

Among different cultivation media, AT5 treatment had the lowest soluble sugar content, and the sugar-acid ratio was significantly lower than other treatments. The quality of tomato fruits treated with AT2 and AT3 was better. In terms of yield, the order of treatment was AT3 > AT2 > AT4 > AT5 > CK > AT1. The first month yield of tomato treated with AT2 was the highest. The yield of tomato treated with AT3 is the highest, which can create better economic benefits. Therefore, it was found that AT2 and AT3 matrix formula could be used as an excellent formula of organic and ecological total nutrient matrix, and could provide the nutritional requirements of tomato throughout the growth cycle, which provided theoretical basis and practical value for the future organic soilless cultivation technology in China. Next we will further improve the industrial production and other issues, and not only tomatoes, other crops can also be made into organic eco-type total nutrient cultivation substrate.

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