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Study on Orbital High-efficiency Cultivation of Green Leaf Vegetables in Sunlight Plant Factory

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ABSTRACT: *Based on the analysis of the cultivation technology route of green leafy vegetables in the solar plant factory, combined with the problems of plant cultivation in the factory, this paper discussed the high-efficiency cultivation technology of track type. The key techniques of track cultivation of green leafy vegetables were studied from four aspects: seedling raising, transplanting, irrigation and management, so as to realize efficient and automatic planting of vegetables and provide reference for people who pay attention to this topic.*

KEY WORDS: *Sunlight plant factory; Green leafy vegetables; Track type high-efficiency cultivation*

Introduction

As an efficient agricultural system, plant factories can use various facilities to achieve high-precision environmental control. However, at present, although natural light and artificial light can be used to promote plant growth, there is a problem of low automation rate in planting green leafy vegetables, which makes it difficult to recover the factory construction cost in a short time, which is not conducive to the construction and development of the factory. Adopting track-type high-efficiency cultivation technology can solve the problem of low production efficiency by improving the automation rate, thus contributing to the development of modern agriculture.

1. Technical route of cultivation of green leafy vegetables in solar plant factory

In the cultivation of green leafy vegetables, the solar plant factory mainly includes two factories, i.e., nursery and vegetable, which are composed of buffer room, liquid conditioning room, control room and other functional areas, which can control the growth environment of vegetables. In the nursery factory, the vertical substrate is mainly used for vegetable cultivation. After seeds are sown, they enter

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the functional area, and the seedlings are raised by regular irrigation [1]. Using the liquid conditioning room, the nutrient solution can be prepared, the PH value, EC value and other indicators can be monitored online, and the reference value can be set by computer.When the reference value is reached, the mother liquor or water can be automatically supplemented by the computer, and the nutrient solution can be reused through the recovery pipeline.The vegetable factory adopts deep liquid flow cultivation mode, which can combine the physiological needs of vegetable growth to carry out nutrient solution circulation irrigation, realize the monitoring and management of various environmental indicators such as sunshine, temperature and humidity, and carbon dioxide concentration, and provide good environmental conditions for plant growth.Equipped with a variety of systems, such as temperature control system, uniform air delivery system, light environment regulation system, gas and fertilizer linkage increasing application system, etc., the environmental control technology can be realized [2]. However, at present, in transplanting and harvesting green leafy vegetables, manual production operations are still needed, resulting in more labor and high production costs, resulting in low production efficiency of factories and unable to meet the needs of efficient production of green leafy vegetables.

2 Key techniques of high-efficient cultivation of green leafy vegetables in factory

2.1 Industrialized seedling raising

In the stage of industrial seedling raising, combined with the production characteristics of solar plants, leafy vegetables with short growth cycle and plant height not exceeding 25cm should also be selected.When selecting seeds, the track cultivation technology should be used in combination with the shallow flow irrigation mode, so the varieties that can adapt to the hydroponic mode should also be selected.Through fine selection, the seeds have uniform size, high purity and germination rate, and impurities are removed.Ensure smooth surface and regular shape of seeds, and then load them into the planter, which can be used for automatic sowing.When planting green leafy vegetables, it is necessary to select special seedling medium for leafy vegetables to ensure that they can form clusters after later transplantation and provide support for mechanical operation.Medium-grained perlite and white peat with fiber length less than 10mm can be mixed according to the ratio of 9:1, and fine soil can be added according to the ratio of 1:1 [3].The tray used should be matched with the track cultivation system, with length and width of 434mm and 242mm, hole size of 3cm×3cm, and 288 holes.The plug is made of ABS hard plastic, which has good mechanical properties and can meet the grasping requirements of the robot arm.After soaking and disinfecting with potassium permanganate, it is washed and dried with clear water, and then put into a seeder to realize integrated sowing.After sowing, the plug is located in a closed solar greenhouse, so it is possible to strengthen the control of environmental temperature and humidity by using facilities such as fans and wet curtains, and to manage sunshine by using facilities such as skylights.In a closed space, the substrate can be

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kept moist and water outflow can be avoided.Until the plant grows 2 leaves and 1 heart, it can be transplanted.Through industrial seedling raising, planting green leaf plants can speed up the emergence of seedlings, which can usually be transplanted in 7-10 days.

2.2 Track transplanting

In the track cultivation technology, the track cultivation locomotive and mechanical gripper can be used to complete automatic transplanting, and the plug tray with seedlings can be moved from the nursery factory to the cultivation bed of the vegetable factory.As shown in fig. 1, the trolley can put the planting tray into the carriage, which can be directly pushed in after being transported to the planting bed by rail.The trolley is suspended on the mechanical arm track, and has a supporting farm tool frame, which can be used for fertilization, spraying and weeding operations.Transverse movement along the direction of mechanical arm can meet the requirements of subsection operation.There is friction between the track and the track wheel, which can make the trolley walk smoothly.The cultivation bed is made of aluminum profiles and foam boards, including a liquid supply end and a liquid return end, keeping a drop of 1%, which can meet the requirements of nutrient solution transportation and recovery.Each cultivation bed unit is equipped with multiple groups of cultivation troughs with a width of 25cm, and tracks are laid by fluent strips.After grasping the plug with a mechanical gripper, it is initially put into the planting tray in the bedside area of the cultivation bed.After growing for 10 days, it was pushed to the middle position by rail, and finally pushed to the end area of the bed in 10 days. After reaching the recovery standard, it can be transferred to the recovery area.

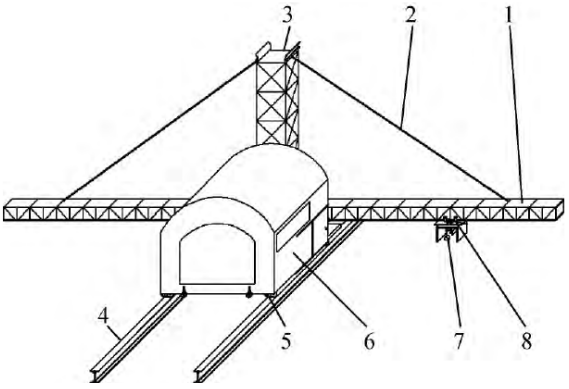

Fig. 1 Schematic diagram of track transplanting system structure

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(1- mechanical arm;2- pull rope;3- tower column;4- orbit;5- track wheel;6- carriage;7- Supporting farm tools;8- moving trolley)

In the process of sectional transplanting, the trolley passes through each area, and can be identified by infrared probe to determine whether the culture tank is full or not. Incomplete will be blocked.In addition, the probe at the lower seedling opening can also be used to confirm whether there are seedlings in the seedling hole. If there are seedlings, the plug tray can fall into the cultivation tank, and if there are no seedlings, they will be transported to the planting buffer area for confirmation by personnel.By realizing rail-type transplanting, the space isolation can be realized while the environment is closed, so that the operation intensity can be reduced, and at the same time, the machinery can be prevented from being damaged due to human error.Because the planting tray can move automatically, people do not need to enter the cultivation area, and the productivity can be greatly liberated.With the adoption of various equipment such as tray pusher and transplanter, the system linkage control can be realized, which can effectively improve the efficiency of seedling transplanting, conveying and vegetable output.It can form a circular chain between seedling raising and vegetable growth, and increase the number of multiple cropping stubbles, thus achieving the goal of increasing the yield of green leafy vegetables.

2.3 Shallow flow irrigation

In the aspect of nutrition supply, compared with deep flow, shallow flow irrigation mode can save water and fertilizer, and at the same time meet the respiratory needs of green leafy vegetable roots.With NFT irrigation system, it is necessary to complete the installation of various facilities such as liquid supply and return pipeline, water pump and nutrient solution pool, and set the time and frequency of liquid supply by using liquid supply switch to realize automatic irrigation.In the process of returning liquid, in order to make full use of the nutrient solution, filter cotton should be set up, and ozone disinfection technology should be used to disinfect the nutrient solution, so that the nutrient solution can finally enter the pool for recycling.In this way, the cultivation tank should be covered with aluminum foil paper.During this period, attention should be paid to ensure that the aluminum foil paper is flat and free from foaming, so as to avoid interference to the flow of nutrient solution. It should be laid from the planting end, and closed at the junction of each section to avoid leakage.Combined with the growth demand of green leafy vegetables, semi-soaking cultivation can be carried out, which can ensure that the root system can absorb enough oxygen while ensuring adequate nutrition supply.When green leafy vegetables are cultivated in a closed space, germs should also be disinfected to avoid a serious blow to factory production. Combined with this requirement, the management of nutrient solution disinfection should be strengthened.Rainwater can be collected for the source of nutrient solution, but it should be primarily filtered by 100μm bag filter, and then finely filtered by 20μm filter.After disinfection by ozone facilities, the growth of germs can be avoided.Fig. 2 is a schematic diagram of the track of the cultivation bed.A flow channel is arranged in the middle of the track to complete the laying of the nutrient solution

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supply and recovery pipeline, which can form an assembly line and ensure that the nutrient solution is circularly transported.

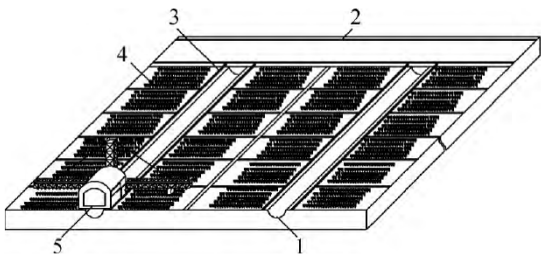

Fig. 2 Schematic diagram of cultivation bed track

(1- flow channel;2 transverse track;3- Longitudinal track;4- Cultivation bed;5- rail car)

2.4 Automation management

In daily lighting, water and fertilizer operations, various systems such as temperature control system and uniform air delivery system can be used to regulate and control on-site facilities, so that the temperature, humidity and lighting time in the factory can be reasonably adjusted.In the cultivation of green leafy vegetables, the temperature is usually kept at 25℃, and the set limit is 30℃. If the limit is exceeded, the fan, sunshade net and other facilities will be automatically turned on to reduce the temperature.In case the temperature is too low at night, the heating facilities will be started to increase the temperature.In the aspect of humidity management, it is usually controlled between 80% and 90%, which can be regulated by ventilation, wet curtain and other facilities.Because it is located in a closed space, there is basically no need for pest control, so the production quality and efficiency can be guaranteed.Before and after harvesting for 7 days, the system will stop adding nutrient solution according to the setting, so as to realize clear water circulation.During crop harvesting, that is, after 30 days of planting, the system will discharge all the liquid according to the set procedure, and then push the planting hole to the harvesting area.With mechanized operation, vegetables can be purchased automatically.After the vegetables are harvested, the disinfection facilities in the factory will start automatically according to the set procedure, and the cultivation bed and other parts will be disinfected and cleaned with 0.1% methyl thiophanate solution, and then wait for the next sowing after drying.Therefore, automatic

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management can be realized in most links from sowing to harvesting, which provides good environmental conditions for planting green leafy vegetables, and achieves the goals of shortening plant growth cycle and improving operation efficiency, thus bringing economic benefits to factory operation.

Conclusion

Strengthening the application of track-type high-efficiency cultivation technology can improve the automation rate of solar plant production, reduce the production cost by shortening the plant production cycle, and bring considerable benefits to plant operation.In the practical production, the technical points of each stage such as seedling raising and transplanting should be made clear, so as to build an efficient industrialized cultivation system of green leafy vegetables, increase the yield of vegetables, and solve the supply problem of green leafy vegetables in cities.

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