INCLINED THIN-FILM SHALLOW CULTIVATION MECHANISM AND ISOLATED HYDROPONIC METHOD USING THE INCLINED THIN-FILM SHALLOW CULTIVATION MECHANISM

BACKGROUND OF INVENTION

1. Field of the Invention

The invention pertains to hydroponic planting systems and, more specifically, to an inclined thin-film shallow cultivation mechanism and an isolated hydroponic method using the mechanism.

2. Description of Related Art

Hydroponic culture, also referred to as soil-less or nutrient solution cultivation, utilizes specialized systems and nutrient solutions to supply nutrients for vegetable seedlings to absorb and grow. Conventional hydroponic systems are often located in greenhouses, incorporating features such as frames, liquid delivery units, and lighting units. Multiple layers of racks are equipped to hold tanks containing the nutrient solution. Floating cultivation trays with multiple slots for cultivation blocks carrying pre-germinated seedlings are placed in these tanks, enabling the roots to absorb nutrients from the solution.

Although traditional hydroponic systems allow for controlled temperature, humidity, and lighting, which promotes pesticide-free and fresh vegetable growth, they also exhibit certain drawbacks. Typically, a single tank supplies nutrient solution to the roots of multiple seedlings, leading to higher water usage. Moreover, interconnected growth environments make the plants vulnerable to cross-contamination. Bacterial or viral infections in one seedling or its surrounding environment can rapidly spread through the nutrient solution, affecting the health and quality of all plants.

To address these issues, the inventor, leveraging extensive experience in hydroponic cultivation, has developed the "Inclined Thin-Film Shallow Cultivation Mechanism and Isolated Hydroponic Method," which significantly

reduces water usage and prevents cross-contamination, ensuring the production of high-quality vegetables.

SUMMARY OF THE INVENTION

The primary objective of this invention is to provide an inclined thin-film shallow cultivation mechanism and an isolated hydroponic method using the mechanism, which drastically reduce water and nutrient solution usage while eliminating the mutual influence of plant growth conditions found in traditional systems. This allows for the cultivation of a large quantity of high-quality vegetables with practical value.

To achieve the aforementioned objectives, the present invention provides an inclined thin-film shallow cultivation mechanism, which is integrated into a hydroponic planting system, the hydroponic planting system includes a frame, a liquid delivery unit, and a lighting unit. The inclined thin-film shallow cultivation mechanism is installed on the frame and connected to the liquid delivery unit to facilitate the cultivation of vegetables, the liquid delivery unit delivers nutrient solution to the inclined thin-film shallow cultivation mechanism, while the lighting unit is positioned above the mechanism to provide light required for the growth of vegetables, the inclined thin-film shallow cultivation mechanism is characterized by the following components: multiple trays, these trays are installed on a layer rack of the frame at a predetermined inclined angle relative to the ground, each tray includes multiple recesses formed on its surface, and the recesses are not interconnected, the liquid delivery unit is connected to both ends of the trays to facilitate the flow of nutrient solution; multiple cultivation mats, these mats are made of materials with a density lower than that of the nutrient solution, allowing them to float, the mats are placed on the top side of the trays, each mat includes multiple cultivation holes positioned to correspond to the recesses of the trays; multiple cultivation blocks, these blocks, which are detachable, are inserted into the cultivation holes of the mats. Each block is designed to hold vegetable seedlings, this design ensures that the nutrient solution is efficiently distributed to support the growth of vegetable seedlings while

allowing for easy maintenance and operation within a hydroponic planting system.

In addition, the present invention provides an isolated hydroponic method utilizing the aforementioned inclined thin-film shallow cultivation mechanism, the method involves setting the tray at a predetermined inclined angle relative to the ground and connecting the liquid delivery unit to both ends of the tray, the cultivation mat is placed on the top side of the tray, allowing the nutrient solution output by the liquid delivery unit to flow between the tray and the cultivation mat, this enables the cultivation mat to float due to the buoyancy of the nutrient solution, the nutrient solution flows continuously along the inclined top side of the tray and enters the recesses of the tray, once each recess is filled with the nutrient solution, any excess overflows, after a predetermined period, the liquid delivery unit halts the output of the nutrient solution, causing the tray to descend and press against the cultivation mat.

BRIEF DESCRIPTION OF THE DRAWINGS

Hereinafter, a better embodiments of the present invention are cited and described in further detail with the drawings, wherein:

Fig.1 is a schematic diagram of a preferred embodiment of the present invention, illustrating the inclined thin-film shallow cultivation mechanism integrated with the layer rack.

Fig.2 is a top view of the tray in the preferred embodiment of the present invention.

Fig.3 is a schematic diagram of the tray, cultivation mat, and cultivation blocks in the preferred embodiment of the present invention.

Fig.4 is an operational schematic diagram of the preferred embodiment of the present invention, showing the nutrient solution causing the cultivation mat to float and flow into the recesses.

DETAILED DESCRIPTION OF THE INVENTION

Below, exemplary embodiments of the present invention are provided in conjunction with accompanying drawings for further detailed explanation as follows:

Firstly, referring to Fig.1 to 3, an exemplary embodiment of the inclined thin-film shallow cultivation mechanism 10 of the present invention is integrated into a hydroponic planting system. The hydroponic planting system includes a frame, a liquid delivery unit, a lighting unit, a temperature control unit, and a control unit. The inclined thin-film shallow cultivation mechanism 10 is installed on a layer rack 1 of the frame and connected to the liquid delivery unit. The liquid delivery unit transports the nutrient solution to the inclined thin-film shallow cultivation mechanism 10 and it recirculates nutrient solution using components such as a reservoir and a pump. The lighting unit, positioned above the mechanism 10, provides the light necessary for vegetable growth. The temperature control unit regulates the greenhouse temperature, while the control unit operates the various components based on preset conditions. These frame, liquid delivery, lighting, and control units are common in conventional hydroponic planting equipment (not illustrated in the drawings), and the nutrient solution composition is a known technique. The innovative aspects of the invention are described below:

The layer rack 1 is inclined at a predetermined angle θ relative to the ground, which is less than 10 degrees, preferably between 1 and 5 degrees. The inclined thin-film shallow cultivation mechanism 10 includes a tray 12, a cultivation mat 14, and multiple cultivation blocks 16.

The tray 12 is fixed on the inclined layer rack 1, forming a rectangular plate structure. It includes a rectangular base plate 22 and multiple side plates 24 surrounding the base plate 22. The top side of the base plate 22 features multiple non-communicating recesses 26, each of which has an arcuate shape. The liquid delivery unit includes a delivery pipe 3 and a recovery pipe 4, both of which penetrate the side plates 24 at either end of the tray 12 and connect

to the top side of the base plate 22. The delivery pipe 3 is positioned at the higher end of the tray 12 relative to the ground, while the recovery pipe 4 is at the lower end. The tray 12 can be made of polystyrene or other materials.

The cultivation mat 14, made of materials with a density lower than the nutrient solution (e.g., polystyrene), is placed on the top of the base plate 22 and between the side plates 24. The mat 14 has multiple cultivation holes 28 corresponding to the recesses 26.

Each cultivation block 16 is made of fibrous or mesh materials, such as plant fibers (e.g., loofah) or synthetic fibers (e.g., sponge or foam). These blocks 16 are detachably inserted into the cultivation holes 28 and carry vegetable seedlings. Specifically, vegetable seeds are sterilized, germinated into seedlings, and placed on the cultivation blocks 16, which are then inserted into the cultivation holes 28. The roots of the seedlings gradually grow into the recesses 26.

Additionally, the underside of the base plate 22 and the side plates 24 of the tray 12 may be covered with light-blocking materials such as black fabric or plastic sheets to prevent light exposure, a known technique not shown in the drawings.

Key features and functionalities of the inclined thin-film shallow cultivation mechanism 10:

When the liquid delivery unit transports nutrient solution through the delivery pipe 3 to the top side of the base plate 22, the solution flows between the tray 12 and the cultivation mat 14. The buoyancy of the nutrient solution causes the mat 14 to float (approximately 0.5 to 1 cm), as shown in Fig.4. The solution then flows along the inclined top side of the tray 12 and naturally enters the recesses 26. The roots of the vegetable seedlings, extending into the recesses 26, are immersed in the solution and absorb nutrients to grow. Once the recesses 26 are filled, the excess solution overflows into the recovery pipe 4 and is recirculated by the liquid delivery unit to the delivery pipe 3. After all the recesses 26 are sufficiently filled, the liquid delivery unit halts, and the

tray 12 descends to cover the mat 14. This isolates the recesses 26, ensuring that the nutrient solution only connects with the cultivation blocks 16 above.

The growth rates of various vegetables differ, leading to variations in the root growth within the recesses 26. The liquid delivery unit's nutrient solution output can be adjusted based on vegetable types, altering the floating height of the cultivation mat 14. A faster output results in a higher floating height (up to 1 cm), while a slower output reduces the height (around 0.5 cm). Once the recesses 26 are filled, the delivery unit halts nutrient solution output, resuming as needed based on root absorption rates. The capacity of each recess 26 accommodates the nutrient solution and root volume necessary for vegetables at full growth, determined through experimentation.

By utilizing the inclined design of the tray 12, the nutrient solution flows naturally between the tray 12 and the cultivation mat 14, forming a thin film. Unlike conventional hydroponic systems with large tanks, the invention employs multiple recesses 26 to contain the solution and roots, significantly reducing water and nutrient solution usage. The system also recirculates excess solution for reuse.

When nutrient solution delivery halts, the tray 12 covers the mat 14, isolating the recesses 26 from direct light. This reduces algae or microorganism growth, maintaining nutrient stability. Moreover, the isolated structure of each recess 26 prevents cross-contamination, even if some cultivation blocks 16 or recesses 26 encounter bacterial or algal growth. This ensures healthy and uncontaminated vegetable growth compared to non-isolated systems.

The inclined angle of the layer rack 1 and tray 12 is optimized between 1 and 5 degrees for efficient solution flow without reducing recess capacity. Adjustable height structures for the rack's higher end allow for angle modifications, achieved using mechanisms like screws or hydraulic systems.

The tray 12 can also be designed with an inclined base plate 22 on a flat layer rack 1, achieving the same effect of inclined solution flow between the tray 12 and cultivation mat 14.

The invention also provides an isolated hydroponic method utilizing the inclined thin-film shallow cultivation mechanism 10. First, the tray 12 is set at a predetermined inclined angle relative to the ground by inclining the layer rack 1 of the frame. The tray 12 is fixed to the inclined rack, and the delivery pipe 3 and recovery pipe 4 of the liquid delivery unit are connected through the side plates 24 at both ends of the tray 12, linking to the top side of the base plate 22. The cultivation mat 14 is then placed on the top side of the base plate 22 of the tray 12. Subsequently, cultivation blocks 16 with vegetable seedlings are inserted into the cultivation holes 28 of the cultivation mat 14.

Next, the liquid delivery unit is activated to output the nutrient solution, which flows onto the top side of the base plate 22 and into the space between the tray 12 and the cultivation mat 14. The buoyancy of the nutrient solution causes the cultivation mat 14 to float. The solution continues to flow along the inclined top side of the tray 12 and naturally enters the recesses 26. As the recesses 26 gradually fill with nutrient solution, the roots of the vegetable seedlings in the cultivation blocks 16 absorb the nutrients and grow. Excess nutrient solution is collected by the recovery pipe 4 and recirculated back to the delivery pipe 3 by the liquid delivery unit. After an appropriate duration, when all the recesses 26 are filled with nutrient solution, the liquid delivery unit halts, causing the tray 12 to descend and press against the cultivation mat 14.

The above description provides an exemplary embodiment of the invention and is not intended to limit its scope. Variations and modifications can be made by those skilled in the art without departing from the spirit and scope of the invention. The scope of the invention should be determined by the appended claims.

WHAT IS CLAIMED IS:

1.An inclined thin-film shallow cultivation mechanism, settled into a hydroponic planting system, the hydroponic planting system comprising a frame, a liquid delivery unit, and a lighting unit, wherein the thin-film shallow cultivation mechanism is installed on the frame and connected to the liquid delivery unit for growing vegetables, the liquid delivery unit being configured to transport nutrient solution to the thin-film shallow cultivation mechanism and recover it, the lighting unit being positioned above the thin-film shallow cultivation mechanism to provide light necessary for vegetable growth, characterized in that the thin-film shallow cultivation mechanism comprises:

multiple trays, fixed on a layer rack of the frame and inclined at a predetermined inclination angle relative to the horizontal plane relative to the ground, each tray having multiple non-communicating recesses;

multiple cultivation mats, made of materials with a density lower than the nutrient solution, movably placed on the top side of the trays, each cultivation mat having multiple cultivation holes corresponding to the recesses; and

multiple cultivation blocks, detachably inserted into the cultivation holes, for carrying vegetable seedlings;

wherein the liquid delivery unit is connected to both ends of the trays to transport the nutrient solution, allowing the cultivation mats to float due to the buoyancy of the nutrient solution, the solution flows along the inclined trays and naturally enters the recesses, where the roots of the vegetable seedlings in the cultivation blocks extend into the recesses, the nutrient solution forms a thin film as it flows between the trays and the cultivation mats,

and when the delivery of the nutrient solution stops, the trays descend to press against the cultivation mats.

2.The mechanism as described in claim 1, wherein the trays are inclined at an angle of less than 10 degrees relative to the ground.

3. The mechanism as described in claim 2, wherein the inclination angle of the trays is preferably between 1 and 5 degrees.

4. The mechanism as described in claim 1, wherein the frame comprises multiple layer racks, each rack inclined relative to the ground, and the trays have a rectangular plate shape.

5. The mechanism as described in claim 4, wherein each tray comprises a rectangular base plate and multiple side plates surrounding the base plate, with the recesses formed in the base plate, the cultivation mats are placed on the base plate between the side plates, and the liquid delivery unit is connected through the side plates at both ends of the trays.

6. The mechanism as described in claim 2, wherein the higher end of the frame corresponding to the layer racks includes multiple height adjustment devices, the height adjustment devices being configured to adjust the height of one end of the layer racks to change the inclination angle of the trays.

7. The mechanism as described in claim 1, wherein each recess is sized to hold an appropriate amount of nutrient solution and accommodate the root volume of vegetables at full growth.

8. An isolated hydroponic method utilizing the inclined thin-film shallow cultivation mechanism as described in claim 4, comprising: setting the tray at a predetermined inclined angle relative to the ground; connecting the

liquid delivery unit to both ends of the tray; placing the cultivation mat on the top side of the tray; inserting cultivation blocks, each containing vegetable seedlings, into the cultivation holes of the cultivation mat; operating the liquid delivery unit to output nutrient solution, allowing it to flow between the tray and the cultivation mat, causing the cultivation mat to float due to the buoyancy of the nutrient solution; allowing the nutrient solution to continuously flow along the inclined top side of the tray and into the recesses of the tray, enabling the roots of the vegetable seedlings within the recesses to absorb nutrients and grow; allowing excess nutrient solution to overflow once the recesses are filled; and halting the output of nutrient solution by the liquid delivery unit after a predetermined period, causing the tray to descend and press against the cultivation mat.

9. The method described claim 8, wherein the predetermined inclination angle of the trays is achieved by inclining the layer racks of the frame relative to the ground and fixing the trays on the racks.

10. The method described claim 8, wherein the predetermined duration is the time required for the recesses to be completely filled with nutrient solution.