

BRIEF SUMMARY

Therefore, to address the needs and deficiencies described above, methods and apparatus are provided according to the example embodiments for providing for the efficient delivery of nutrients to plants in a hydroponics system.

5 One embodiment provides a method for growing plants, comprising the steps of: positioning a plurality of plants having roots in a single, substantially planar frame, ~~such as and without limitation a polyvinyl chloride (PVC) pipe,~~ located directly ~~substantially~~ above a flume with the roots depending from the frame; causing a liquid such as a water and nutrient solution to flow within the
10 flume, the liquid having a surface defining a distance relative to the frame; and adjusting the distance between the frame and the surface of the liquid. The step of adjusting may comprise moving the flume closer to the frame while maintaining the frame in a stationary position, moving the frame closer to the flume while maintaining the flume in a stationary position, actuating a stopper coupled to the
15 flume or frame, or utilizing a computer device configured to actuate a stopper during certain time intervals, such as without limitation, thirty (30) minutes. The roots of the plurality of plants may be contained within a basket, wherein the basket is suspended within the interior of the flume and/or frame. This basket may be constructed of any material that would permit the roots of the plants to obtain
20 nutrients from the liquid, such as a wire basket or mesh basket.

Another embodiment provides an apparatus comprising a substantially planar frame configured to hold a plurality of plants having roots depending therefrom; a flume positioned directly ~~substantially~~ beneath said frame, said flume having a first end and a second end ~~distance~~ distant from said first end, said flume
25 being adapted for the flow of liquid therein between said first end and said second end, and an adjuster for changing the distance between the surface of the liquid and said frame. The ~~frame~~ flume further comprises a plurality of plant receivers ~~receiving positions~~ for receiving a plurality of plants.

The adjuster comprises a computer system and an actuator, wherein said
30 computer system is configured to transmit signals to the actuator to cause the actuator to control a gate, for example, to rotate the gate about a longitudinal axis with respect to the ~~frame~~ flume. The computer system may be configured to transmit signals to cause the actuator to rotate a gate at 30 and 90 degree angles with respect to the ~~frame~~ flume.

Each flume 12 may comprise a plurality of plant receivers 16 for holding a plurality of plants 14. The plant 14 may be secured within its respective plant receiving position receiver 16 via a frame 18, such as and a wire or mesh basket, which is coupled to resides within the plant receiver 16 receiving position. Each The frame 18 is
5 configured to receive a plant whereby the roots depend therefrom, and fall into the flume 12 interior, and the top portion of the plant remains above the profile of the flume 12.

Figure 3A provides a cross-sectional view of a farming system according to an embodiment of the present invention with the roots 19 immersed in water or nutrient solution. As shown in Figure 3A, the water or nutrient solution is configured to reach a
10 predetermined level 23. Those skilled in the art will recognize that any predetermined level may be utilized in order to expose a desired percentage of the roots 19 of plants 14 to the water or nutrient solution.

In the embodiment shown in Figure 3B, a timer 31 and a lifting motor 32 are utilized as the adjuster mechanism 24 to lift the plants 14 out of the water or nutrient
15 solution to expose roots 19 to air. At a predetermined time the lifting motor 32 receives a signal from the timer 31, and in response, lifts the frames 18 out off of the flume 12, thereby exposing the roots 19 of the plants 14 to air. Those skilled in the art will recognize that, in addition to a timer and lifting motor, any number of other mechanisms may be utilized to control the height of the water within the flume 12.

For example, and without limitation, each flume may comprise a gate 36, referring again to Figure 3A, which is positioned opposite a first end. The gate 36 may
20 comprise any number of structures, including without limitation a damming device configured to conform to the interior profile of the flume to prevent the passage of liquid. The gate 36 is positioned in such a manner as to permit liquid to pass, and hence, lower
25 the level of the liquid within the flume. When the water level is lowered, the roots of the plurality of plants are exposed to air. The damming device may rise to prevent the passage of liquid past the gate. The gate 36 may rise in response to a signal from
adjuster, for example, upon a certain amount of time passing. For example and without
30 limitation, this amount of time may comprise thirty (30) minutes. Once the gate 36 has risen to a certain level, the level of the liquid within the flume is higher, and thus, the roots of the plurality of plants are immersed within the liquid.

Figure 7 illustrates the steps taken by any type of user, wherein user not only includes a human user, but also, any type of computer, computer-implemented process, or the like, in operating the system of the present invention. As shown in Figure 7, method 700 begins at step 70, and proceeds to the step of positioning a plurality of plants having roots in a frame substantially above a flume, wherein the roots depend from the frame. Each frame may comprise any mechanism or structure capable of holding a plant and roots of plant, for example and without limitation, in a basket made of wire, mesh, or any other type of material which may permit the ingress of water to the roots of the plant.

Method 700 then proceeds to step 72, which causes a liquid to flow within the flume, wherein the liquid has a surface which defines a distance relative to the frame.

Once liquid is flowing within the flume, method 700 comprises adjusting the distance between the frame and the surface area of the liquid in step 73. This step may involve any number of methods or structures, including an adjuster, such as a timer used in conjunction with a lifting motor, a variable drive pump, or a gate or damming device placed within the flume. In the embodiment utilizing a variable drive pump, at any given time, the variable drive pump may adjust its speed, and therefore flow output, to compensate for the current status of the valves. Thus, more values are open to create more flow, and vice versa. Method 700 terminates at step 74.

The various example embodiments of the present invention are beneficial for a number of reasons. For example, by adjusting the distance between the frame and the flume, the present invention exposes plants positioned in the frame to air for a period of time, and nutrient solution for a period of time, in such a manner that results in increased nutrient delivery to the plants and hence expedited plant growth. By improving nutrient delivery and increasing the speed of plant growth, the present invention allows farmers to address consumer demand more quickly, and also, realize higher revenue.

Additionally, there are other benefits provided by the various embodiments of the present invention over the prior art. In hydroponics techniques, the nutrient film technique (NFT) uses a continuous flow of liquid, which means in part that the pump requirements of NFT are a function of the aggregate amount of flow across the given channels. In the various embodiments of the present invention, the

THAT WHICH IS CLAIMED:

1. A method for growing plants, comprising the steps of:
positioning a plurality of plants having roots in a single, substantially planar frame
5 ~~substantially located directly~~ above a flume with the roots depending from the frame;
causing a liquid to flow within the flume, the liquid having a surface defining a distance
relative to the frame; and
adjusting the distance between the frame and the surface of the liquid.
- 10 2. The method of Claim 1, wherein adjusting comprises moving the flume ~~closer~~ relative to
the frame in a substantially vertical direction while maintaining the frame in a stationary position.
3. The method of Claim 1, wherein adjusting comprises moving the frame ~~closer~~ relative
to the flume in a substantially vertical direction while maintaining the flume in a stationary position.
- 15 4. The method of Claim 1, wherein adjusting comprises ~~an adjuster~~ actuating a stopper
coupled to the flume or frame through operation of an adjuster.
5. The method of Claim 4, wherein said adjuster comprises a computer device configured to
20 actuate a stopper during certain time intervals.
6. The method of Claim 5, wherein said certain time intervals may comprise thirty (30)
minute time intervals.
- 25 7. The method of Claim 1, wherein the ~~frame~~ flume comprises a polyvinyl chloride (PVC)
pipe.
8. The method of Claim 1, wherein said liquid comprises a water and nutrient solution.
- 30 9. The method of Claim 1, wherein said roots are enclosed within a basket.
10. The method of Claim 9, wherein said basket comprises a wire mesh basket.

11. The method of Claim 1, wherein the step of adjusting comprises utilizing a valve to control the flow of water to the ~~frame~~ flume.
12. An apparatus comprising:
5 a substantially planar frame configured to hold a plurality of plants having roots depending therefrom;
a flume positioned substantially directly beneath said frame, said flume having a first end and a second end ~~distance~~ distant from said first end, said flume being adapted for the flow of liquid therein between said first end and said second end, and
10 an adjuster for changing the distance between the surface of the liquid and said frame.
13. The apparatus of Claim 12, wherein said frame further comprises a plurality of ~~plant receiving positions~~ apertures for receiving a plurality of plants.
- 15 14. The apparatus of Claim 12, wherein ~~the~~ said adjuster comprises a computer system and an actuator, wherein said computer system is configured to transmit signals to ~~the~~ said actuator to cause ~~the~~ said actuator to control a gate.
- 20 15. The apparatus of Claim 14, wherein ~~the~~ said computer system is configured to transmit signals to cause ~~the~~ said actuator to rotate a said gate about a longitudinal axis with respect to ~~the~~ said flume frame.
- 25 16. The apparatus of Claim 15, wherein ~~the~~ said computer system is configured to transmit signals to cause ~~the~~ said actuator to rotate a said gate at 30 and 90 degree angles with respect to ~~the frame~~ said flume.
- 30 17. The apparatus of Claim ~~14~~ 12, wherein ~~the~~ said adjuster is coupled to ~~the~~ said frame, and is configured to raise and lower ~~the~~ said frame with respect to ~~the~~ said flume in a substantially vertical direction.
18. The apparatus of Claim 12, wherein ~~the~~ said adjuster is coupled to ~~the~~ said flume frame, and is configured to raise and lower ~~the~~ said flume with respect to ~~the~~ said frame in a substantially vertical direction.

19. The apparatus of Claim 12, wherein ~~the~~ said adjuster comprises a damming device positioned in the interior of ~~the~~ said flume to control the passage of water past ~~the~~ said damming device.