A VERTICAL GROWING SYSTEM AND METHOD

Field of the Invention

The invention relates to agricultural production and, in particular, for the growing of harvestable plants in a vertically oriented arrangement

Background

The arrangement of plants growing vertically provides for a smaller foot print, which is at a premium in an urban environment. Unfortunately, the infrastructure required to achieve an economical viable vertical farm is substantial, and the means of supplying nutrients for efficient growth, and the eventual harvesting, requires equally substantial infrastructure to access the growth units in which the plants grow.

Some systems do provide for a motorized access to the growing units such that, for harvesting, the growing units are lowered and subsequently raised back into place. In some instances, this involves individual motors for each growing unit, with more efficient systems having a centralised motor to manage the movement of several growing units.

The infrastructure cost for such a system is also considerable, and difficult to scale as the system grows higher, and the weight through greater numbers of growing units are

added. Further, operational control to manage a mechanised system, at a reasonable scale represents significant complexity.

Summary of Invention

In a first aspect, the invention provides a vertical growing system comprising: a mechanism having an endless loop conveyor extending between an upper rotation device and a lower rotation device, said conveyor arranged to rotate about said rotation devices; the conveyor carrying a plurality of growing units, each growing unit having a plurality of planting units, each planting unit arranged to receive a plant; wherein said growing units are arranged to receive a biasing mass on a first side of the conveyor; said weighted growing units arranged to form a weight imbalance applied to the conveyor, said conveyor arranged to rotate based upon the applied weight imbalance.

In a second aspect, the invention provides a method for vertically growing plants, the method comprising the steps of: a mechanism having an endless loop conveyor extending between an upper rotation device and a lower rotation device, said conveyor arranged to rotate about said rotation devices; carrying a plurality of growing units on an endless loop conveyor extending between an upper rotation device and a lower rotation device, said conveyor arranged to rotate about said rotation devices, each growing unit having a plurality of planting units, each planting unit arranged to receive a plant; receiving a biasing mass by said growing units on a first side of the conveyor; said weighted growing units forming a weight imbalance applied to the conveyor, and

so; said conveyor rotating based upon the applied weight imbalance.

The invention provides for a weighted rotational mechanism, which provides both manual and mechanical access to growing units, without the automated systems of the prior art. Thus, a vertical growing system, according to the present invention, provides a lower cost option, with less complexity and greater scalability.

As such, while a system according to the present invention may be several meters high, there is no need for the use of scissor lifts or any lifting devices to harvest the plants which may considerably lower costs of operations, increase in safety and an increase in efficiency.

Brief Description of Drawings

It will be convenient to further describe the present invention with respect to the accompanying drawings that illustrate possible arrangements of the invention. Other arrangements of the invention are possible and consequently, the particularity of the accompanying drawings is not to be understood as superseding the generality of the preceding description of the invention.

Figure 1 is an elevation view of one embodiment of a vertical growing system according to the present invention;

Figures 2A and 2B are elevation views of two embodiments of a growing unit according to the present invention;

Figure 2C is an elevation view of a growing unit attachment according one embodiment of the present invention;

Figures 3A to 3C are sequential elevation views of a growing unit according to a further embodiment of the present invention, and;

Figure 4 is a schematic view of a nutrient supply system according to a further embodiment of the present invention.

Detailed Description

Figure 1 shows a vertical growing system 5 having a plurality of growing units 10. The growing units 10 are arranged on endless loop conveyor, in this case a chain 15. In place of a chain, a belt or other conveyor may be used, as long as the element is of sufficient tensile strength and flexibility to function as required. The mechanism 7 includes upper and lower rotational devices, in this case, geared arrangements 40 such that the chain 15 rotates about the geared arrangement 40 and consequently the growing units are arranged to follow the chain 15 to which they are attached. The upper and lower rotation

devices may be gears, hand wheels, rollers, pulleys (driven or freewheeling) or other such means to provide a means of supporting the endless loop conveyor 15.

Each of the growing units 10 includes a casing 30 and a plurality of planting units 20. In this embodiment the casing 30 includes four vertically positioned planting units 20. It will be appreciated that the growing units may have several different orientations with different arrangements of the planting units within the casing 30. The casing 30 further includes a nutrient storage tank 37 arranged to receive nutrients which filter 34 through the planting units 20 and collect in the nutrient storage tank 37 at the base of the casing 30.

The mechanism 7 may include guide rails, or guide wires, to guide the growing units through the rotational path. The guide rails may be vertical on the left 16 and right 18 sides. The guide rails may also include arcuate shape rails, to guide the growing units on rotation about the geared arrangement 40. A similar arrangement can be achieved using guide wires.. If a single attachment is provided, while engagement and disengagement may be rapid, the growing units may tend to sway. Using a guide rail may hinder or prevent swaying, allowing for a more simple and rapid attachment. To moderate the sway, an attachment Fig 2C could be used for the growing units 10 to be attached to.

The mechanism 7 may include limiters that only allow clockwise motion. Such limiters may be in the form a ratchet providing one way motion. Thus, when a force (such as a biasing mass) is applied in an anti-clockwise direction or for instance if a downward

force is applied on the left side 18 of the mechanism, rotation is prevented. However, if a force is applied on the right side 16, clockwise motion is permitted, with the right side moving downward 22. Being part of a continuous loop, the left side 18 will move up 24. In order to apply a biasing mass to the system, to initiate clockwise motion, an uppermost growing unit 32 on the right side 16 is arranged to receive a nutrient inflow 12, which may be triggered by a growing unit 10 when it is in proximity. As will be described later, a nutrient storage tank 37 may be emptied through triggering a spring loaded valve 35. It will be appreciated that, to extend the automation aspect of the invention, the nutrient flow may also include a spring loaded valve to release nutrients to flow into the growing unit once triggered by the positioning of the growing unit. The nutrients are arranged to pass 34 through each of the planting units 20 so as to provide sustenance for healthy growing. Excess nutrients then collect in the nutrient storage unit 37 at the base of the growing unit 32, thus the growing unit is now "weighted". The filled nutrient storage unit 37 of the weighted growing unit then provides a weight imbalance on the right side 16 as compared to the left side 18. This weight imbalance is sufficient to drive the mechanism 7 such that the right side 16 moves down 22 and the left side 18 moves up 24. In this way the supply of nutrients to each growing unit provides two beneficial results. First, the obvious nutrient supply aids in efficient growing, and second, the loaded growing units apply a clockwise force so as to drive the mechanism.

It follows that the provision of this nutrient load initiates the type of driving force that the prior art provides through a motorised system.

Ideally, the static friction within the mechanism may be minimised, such that the weight imbalance provided by the filled nutrient tanks does not need to overcome a significant frictional load before initiating movement. The mechanism, when the nutrient tanks are empty may be close to metastable state, such that, only a relatively small load is required to initiate movement.

It will be appreciated that if there is insufficient need for the volume of nutrients to be added to each growing unit to cause the required weight imbalance, then water could be used as the biasing mass in place of the nutrients. In a further embodiment, if neither a sufficient volume of nutrients nor water is required, the nutrients storage tank may be arranged to receive water directly so as not to pass through the planting units.

It will be further appreciated that to initiate rotation, when only the uppermost growing unit 32 has received a nutrient load, then the mechanism 7 may be manually rotated so that more than one growing unit receives the nutrient load to create the imbalance.

For the system 5, the intention is to harvest plants, replace growing units or replant the planting units at the lower most portions of the system for more efficient and safer access. To this end, growing units 14A, 14B, 14C may variously be used for harvesting, receiving or replacing of the growing units. If either of these three actions is required, given the low friction mechanism 7, it may be necessary to lock rotation of the mechanism 7 so as to provide an opportunity for the harvesting, receiving or

replacement tasks without the mechanism rotating unintentionally. Such a lock may be a simple bolt manually applied by an operator. Alternatively, a brake may be applied to the mechanism itself to prevent rotation. It will be appreciated, that there are several different ways of selectively preventing rotation which will be apparent to the skilled person.

Figures 2A and 2B show alternative arrangements of growing units 10, 45. The growing unit 10 of Figure 2A shows an attachment bracket 25 mounted to a top end of the case 30. As shown in the previous figure, a nutrients storage tank 37 is provided in the base with a spring loaded release 35. In one embodiment, the growing unit 10 may be mounted to the chain 15 using carabiner so as to provide a fast attachment and release of the growing units. If a more secure attachment is required, attachment may be made using a shackle, or a complementary bracket on the conveyor to allow the growing unit to be screwed or bolted in place. Having a secure attachment spaced evenly along the chain 15 may minimize sway and act as a safety measure. In a further embodiment, the growing unit could be hooked onto the chain. Such a hook may provide a snap fitting or a simple engagement with a spring loaded dowel again for easy release and engagement. In a still further embodiment, the attachments may be double hook 47 as shown in Figure 2C, mounted to the conveyor 53, having a top hook 49 and a second hook 51. The growing unit may be arranged to connect to both hooks by inserting the hooks into corresponding slots in the back of the growing unit, and so providing both easy engagement and disengagement, while still limiting sway. It will be noted that the second hook 51 may be replaced by a bottom ring (not shown), with the

slot replaced by a strap having a carabiner to attach to the ring. In one non-limiting example, the first hook 49 and second hook 51 (or ring) may be separated vertically by a sufficient distance to minimise sway.

The spring loaded valve 35 may be arranged to release liquid from the nutrients storage tank 37. For instance, the spring loaded valve 35 may contact a surface when the growing unit reaches the bottom of the conveyor, such as the position of the growing unit 14B in Figure 1. On contact with the surface, the spring loaded valve is activated, opening up the valve with the nutrients pouring from the bottom as will be explained with reference to Figures 3A to 3C.

Figure 2B shows an alternative arrangement whereby a switch 50 is positioned on a side of the case 30 with the switch arranged to open valves in the base of the nutrients storage tank 37. As the growing unit passes a designated point, a lug 55, positioned external to the growing unit, activates the switch 50 and thus releasing the fluid. It will be appreciated that other means of automatic or selective release of liquid may be possible.

Figures 3A to 3C show the sequential process of the nutrient liquid being released using the example of Figure 2A. Here, the growing unit 10 travels downward 70 bringing the spring loaded valve 35 into contact with a surface 65. On depression 80 of the spring loaded valve 35, apertures 85 are opened in the base of the casing and storage tank 37. As shown in Figure 3C, the liquid 75 within the tank 37 is released 90 through the

apertures 85 and so emptying the tank 37, reducing the weight of the growing unit. On release of the movement lock (not shown), the free movement of the system can continue, with the now lighter growing unit permitted to rise on rotation of the mechanism.

Figure 4 shows an embodiment of a nutrient supply system 140 according to the present invention. As discussed with reference to Figure 1, nutrients are supplied 12 to an uppermost growing unit 32. The system of Figure 4 provides an automated process for achieving this, as compared to a manual nutrient supply.

As grow unit 100 drops down in direction 105, it pushes a switch 115 which rotates 125 from a closed position 124 to an open position 122. This results in a directional pull 113. The top end of switch 115 is attached to a chain 120 which transmits the pull 113 in a similar direction 117 via the rollers 110 to pull up a weighted tapered plug 139 from a closed position 137 to 135 allowing the nutrient solution 155 stored in the reserve tank 150 to be released into grow unit 100. The weighted tapered plug is held in a vertical tube holder 141.

The reserve tank 150 is filled up via input 160 when a float valve 165 is below the desired reserve tank level. A length of plastic pipe (not shown) can be added at reserve tank opening 137 to direct the nutrient flow 145 to grow unit 100.

The system is balanced such that a known volume of nutrients may initiate movement of the growing unit 100, which will move downwards. When the top of the grow unit reaches the bottom of switch 115, the switch rotates back from the open position 122 back to the closed position 124. To this end, the switch may be biased towards the closed position either by a spring or an offset weight of the switch member. Via chain 120, this allows weighted tapered plug 139 to slide down holder 141 to the closed position 137, closing the nutrient release.

The process can therefore continue without direct operator supervision until the nutrient supply 160 is depleted. Subject to the required volumes, this may be a matter of days or weeks, leading to a highly efficient and automated vertical growing system.

In a still further embodiment, the nutrient supply system of Figure 4 may be coupled with the nutrient retrieval system of Figures 2A or 2B. Consequently, the nutrient outflow at the bottom of the cycle, may be collected via the spring loaded release to a sump tank where a small pump may recirculate the nutrient solution back to the top reserve nutrient tank 150. That is, the inflow 160 may be provided directly via a pump, or indirectly by a buffer tank intermediate the inflow 160 and the pump. This way, it can go on ad infinitum ie hence highly efficient in terms of water use and automation.

Claims

1. A vertical growing system comprising

a mechanism having an endless loop conveyor extending between an upper rotation device and a lower rotation device, said conveyor arranged to rotate about said rotation devices;

the conveyor carrying a plurality of growing units, each growing unit having a plurality of planting units, each planting unit arranged to receive a plant;

wherein said growing units are arranged to receive a biasing mass on a first side of the conveyor;

said weighted growing units arranged to form a weight imbalance applied to the conveyor, said conveyor arranged to rotate based upon the applied weight imbalance.

2. The vertical growing system according to claim 1, wherein the endless loop conveyor is a belt or a chain

3. The vertical growing system according to claim 1 or 2, wherein the rotation devices are hand wheels, gears, rollers or pulleys.

4. The vertical growing system according to any one of claims 1 to 3, wherein the growing units include a storage tank at a base of the casing, said storage tank arranged to receive a liquid biasing mass.

5. The vertical growing system according to claim 4, wherein the storage tank includes a release valve for releasing the liquid at a designated location.

6. The vertical growing system according to claim 5, wherein the designated location is at a position corresponding to the lowermost growing unit, said location including a surface such that a release valve contacts the surface and consequently releasing said liquid.

7. The vertical growing system according to any one of claims 1 to 6, wherein the biasing mass includes a supply of nutrient liquid applied to an uppermost growing unit and released from a lowermost growing unit.

8. The vertical growing system according to claim 7, further including a nutrient supply tank arranged to provide the supply of nutrient liquid to the uppermost growing unit.

9. The vertical growing system according to 8, further including a switch, said switch arranged to be triggered by a block on the uppermost growing unit such that, on triggering, the nutrient supply tank supplies nutrient liquid to the uppermost growing unit.

10. A method for vertically growing plants, the method comprising the steps of:

a mechanism having an endless loop conveyor extending between an upper rotation device and a lower rotation device, said conveyor arranged to rotate about said rotation devices;

carrying a plurality of growing units on an endless loop conveyor extending between an upper rotation device and a lower rotation device, said conveyor arranged to rotate about said rotation devices, each growing unit having a plurality of planting units, each planting unit arranged to receive a plant;

receiving a biasing mass by said growing units on a first side of the conveyor;

said weighted growing units forming a weight imbalance applied to the conveyor, and so;

said conveyor rotating based upon the applied weight imbalance.