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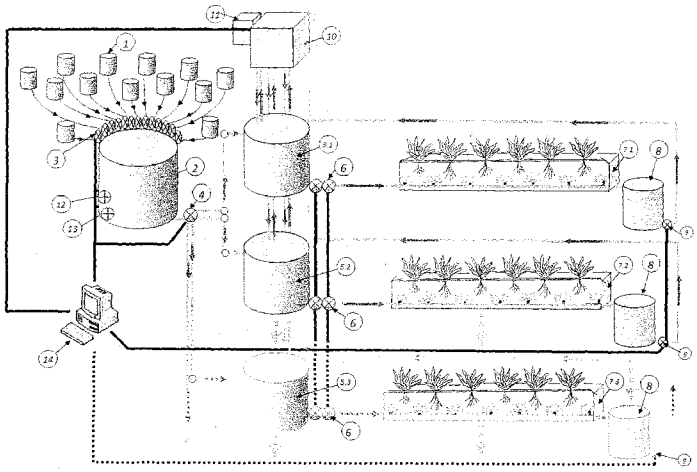
(54) Title: AUTOMATED AEROPONIC PLANT GROWING SYSTEM

Figure 1



(57) **Abstract:** A fully automated aeroponic plant growing system, is monitored and controlled by only a central digital automatic operation unit for all the individual parts and on line monitoring capability. It has the ability to simultaneously support multiple aeroponic crops or growing treatments with different nutritional requirements, or only one aeroponic crop. Simultaneously prepares, sterilizes and controls all individual and different nutrient solutions needed to feed plants, which are sprayed onto the roots throw the recirculation support system. It has the ability to control and adjust at any given value the root zone atmosphere temperature into growing chambers or vessels, by monitoring and controlling the temperature of nutrient solution sprayed to the roots, offering ideal root growth conditions to grow plants. This is made entirely of suitable insulating material, Capable to support parallel or not, all known hydroponic and Aeroponic cultivation systems and suitable for any open or closed environment.

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AUTOMATED AEROPONIC PLANT GROWING SYSTEM

Field of the Invention

The present invention relates to plant cultivating systems using aeroponics.

Prior Art

Aeroponics, which is also called "air culture" or "soilless culture", is presently the most modern and technologically evolved cultivation system for plant production. In aeroponics, plants are grown in the absence of any substrate. The nutrient solution is sprayed on the roots of the plants, which roots grow suspended in the air within closed trays or vessels.

The ideal conditions of absorption of oxygen, water and nutritious elements by the plants' root system, results in the more rapid growth and maturation rates of the plants, the bigger density of planting and the easier control of enemies and diseases. Also, plant cultivation can be repeated year-round without interruption.

Air culture systems available today around the world for research or for productions purposes, are closed cultivations systems, usually consisting of:

- A central control unit (head tank), or peripheral units for managing all parts of the system and containers for nutrient solution automatic preparation, by mixing nutrient stock solutions with automatic adjustment of pH and conductivity values.
- Automatic irrigation system for spraying or injecting the nutrient solution under low of high pressure on plants' roots, controlling the duration and frequency of spraying with automatic regulation of the time and frequency of injection. Nutrient solution is reciprulated from the plant growing trays or vessels back to the central control unit.
- Trays or vessels into which develops the root system of plants, made vertically or horizontally from plastic or metal materials of different types and in different shapes and forms. In many cases the container in which plants are grown, contains the nutrient solution.

The Aeroponic systems which have been constructed so far have one major drawback, which has prevented their widespread application. This is that so far there was no possibility to adjust the temperature at the desired level for each crop and each plant. The temperature of this area is a critical factor in relation to the type of crop plant and external temperature conditions. Also containers or channels into

which development the root systems occurs, are not insulated properly. Plastic or metal materials mainly used today for channels or receptacles into which the developed root systems do not offer insulation.

Moreover a major drawback of the currently known aeroponic cultivation systems today is that they can not simultaneously support multiple cultures of various plants (multicrop), or cultures with different nutritional needs.

Description of the Invention

The present invention describes for the first time a fully automated aeroponic plant growing system, which is much more comprehensive than the existing technology, which solves crucial problems tof the known technology of aeroponic systems. The system of the invention comprises the following parts:

- Separate reservoirs for the individual stock solutions and for the acid container to adjust the pH, for every single nutrient element.

Advantageously, there are a total of up to thirteen stock reservoirs. Therefore, the present aeroponic system becomes an unlimited multicrop system, which has the ability to prepare every kind of formulation of nutrient solutions for each different plant crop. Thus, it can simultaneously support multiple different crops, or several nutritional treatments on the same crop, which gives an important advantage. In the present invention, the nutrient containers may be limited to three when only one crop is cultivated (monoculture).

- The main container (head tank) into which the nutrient solutions are automatically prepared for every single crop, is filled with water and the appropriate quantities of nutrient elements from the separate stock solution containers, with automatic control adjustment of pH and conductivity.

The preparation of all the nutrient solutions according to the needs of the growing crops is fully automatically controlled.

- The main crop tanks, namely the nutrient solutions' separate reservoirs or containers for each crop: The nutrient solution for each crop is prepared into the main container and is transferred to the corresponding individual crop tank, from which is injected to provide a nutrient mist directly to the exposed root portions of the plants. This is an important advantage over existing technologies. For small aeroponic systems or single crop systems, just a single one container is needed.

- The growing channels or vessels (or containers), which can be made of various shapes or forms and can be used for flat or vertical cultivation, into which the root system of the plants is developed. These channels or containers are made from expanded polystyrene or other suitable insulating material. The thermally insulated space for root development gives a significant advantage over the existing art. The aboveground part of the plants grown up and out of the channels, or receptacles, in the surroundings of the system. The aeroponic system of the present invention, because protects the root environment from temperature disturbances, is suitable to operate in a closed (indoors) .or an open environment (outdoor).

- Automatic irrigation system, providing the nutrient solution by pumps, transport pipes and sprayers or sprinklers, spraying or misting under pressure (high or low) directly to the root portions into the growing channels or containers, with automatic setting of time and frequency of mist provision. It is a closed circuit supply system, recirculating the nutrient solution from the growing channels or containers back to the crop tanks via rec tanks and return pumps or by natural flow.

- Automatic sterilization of the nutrient solution, so as to avoid the use of phytochemicals I.e. plant protection chemichals).
- Central automatic digital control system-operating by computer, monitoring and controlling all the individual parts of the system, and the possibility to on-line control.

A major advantage of the present invention is the automatic regulation and control of the temperature of the development area of the root system, which is achieved by adjusting the temperature of the nutrient solution administered to the culture containers or in the center, so that temperature is controlled to remain at excellent levels for development of any culture (cultivation) , regardless of the temperature prevailing outside. The system has the ability to regulate the temperature of the supplied nutrient solution separately for each crop .

The temperature of the rhizosphere (roots) plays a very important role in plant growth because it is associated with the radical metabolism and assimilation of nutrients. In evolution, various plant species have adapted to different environments, cold or hot in respect of temperature. Consequently, the optimal growth temperature of the rhizosphere differs greatly among plant species, and even within the same

plant species. For example, the subtropical variety's lettuce *Lactuca sativa* rhizosphere requires high temperatures, while the variety *iceberg* requires very low temperatures, about 7 °C . The rooting of plant cuttings in many cases requires temperatures of about 24-28 °C. The regulation and control therefore of the rhizosphere temperature for each growing treatment, or by the aeroponic method described in the present invention is an important and critical factor.

An important advantage is also the use of expanded polystyrene or other suitable insulating materials for for heat insulation ofthe root growth space.

Furthermore, this integrated and fully automated aeroponic system can support parallel or not and all previously known Hydroponic or Aeroponic plant growing systems.

Figures' description

Figure 1 illustrates a schematic presentation of a fully automated aeroponic plant growing system, supporting simultaneously various plant crops, with different nutritional requirements.

Figure 2 illustrates a schematic presentation of a fully automated aeroponic plant growing system, supporting only one single crop, with only one nutrient solution formulation needed.

In particular the following are illustrated in respect of the numbers referred to in parenthesis:

(1): Reservoirs for the nutrients stock solutions and pH adjustment solution.
(2): Main container (head tank) for the nutrients stock solution.
(3): Automatic preparation and automatic control of nutrient solutions.
(4): Pumps transferring the prepared nutrient solution from the main container to the individual crop tanks.
(5) Main crop tanks or containers (5.1 ,5.2,5.3, ...).
(6): Automatic irrigation system, providing the nutrient solution by pumps with automatic regulation of pressure, time and frequebcy of irrigation.
(7) : Plant growing channels or trays (7.1 ,7.2,7.3 ....).
(8) : Rec tanks for excess nutrient solution collection after spraying or misting the root

system.

(9) : Automatic nutrient solution recirculation pumps.

(10): Automatic temperature control unit for the nutrient solution.

(11): Automatic nutrient solution sterilization unit.

(12): Automatic control and adjustment of pH values.

(13): Automatic control and adjustment of conductivity values of the nutrients' solution.

(14): Fully automated central control and operation digital system.

Description of Figure 2, with reference to the numerals in parenthesis:

(1): Reservoirs for the nutrients stock solutions and pH adjustment solution.

(2): Reservoir or container of the nutrient solution.

1 (3): Automatic preparation and control of nutrient solutions.

(4) Pumps transferring the nutrient solution from the main container to the individual crop tanks.

(5): Plant growing channels or trays where the root system of the plants grow.

(6): Rec tank for excess nutrient solution collection after the root system is sprayed or sprayed (misted).

(7)Automatic nutrient solution recirculation pumps.

(8): Automatic nutrient solution sterilization unit.

(9): Automatic temperature control unit for the nutrient solution.

(10): Automatic control and adjustment of pH values.

(11): Automatic control and adjustment of conductivity values.

(12) Fully automated central digital operating system

Detailed Description of the Invention

The present invention is described in detail below with the aid of two examples and reference to Figures 1 and 2.

Example 1:

- Fully automated plant growing system which can simultaneously support multiple different crops, or several nutritional treatments on the same crop , able to prepare

every kind formulation of nutrient solution for each individual plant crop, comprising of the following parts as shown in Figure 1 :

- The main container (head tank), (2) into witch automatically prepared the nutrient solutions for every single crop, by fulfilling with water and the appropriate quantities of nutrient elements from the separate stock solutions reservoirs(1).
- Separate reservoirs for the individual stock solutions (1), for every single nutrient element(plus the acid container to adjust the pH), making a total of up to thirteen stock reservoirs, having the ability to prepare every kind formulation of nutrient solution.
- Fully automatically preparation of all the nutrient solutions (3), according to the needs of each growing crop, with automatic adjustment of pH (12) and conductivity values (13).
- Nutrient solutions' separated cop tanks (5.1 ,5.2,5.3, ..) for each crop. The nutrient solution, automatically prepared into the main container, is transferred by pumps (4) to the corresponding individual crop tank.

- Growing channels or trays (7.1 ,7.2,7.3, ..), of various shapes or forms, for flat or vertical cultivation, into which the root system of the plants is developed. These channels or trays are made from expanded polystyrene or other suitable insulating material. The area wherein develops the root system of the plants is thus thermally insulated. The above-ground part of the plant grows up and out of the channels or trays (receptacles), in surroundings that can be indoor, greenhouse or outdoors.

- Automatic irrigation system, providing the nutrient solution by pumps (6), transport pipes and sprayers or sprinklers, spraying or misting under pressure (high or low) directly to the root portions into the growing channels or containers, with automatic setting of time and frequency of mist provision. The system recirculates the nutrient solution from the growing channels or trays back to the crop tanks via rec tanks (8) and return pumps (9), or by natural flow.
- Automatic temperature control of the rizosphere development space into channels or trays, by adjusting the nutrient solution temperature in the crop tanks (10), so that it remains at excellent levels for development of any culture, regardless of the temperature prevailing outside. The system has the ability to regulate the temperature of the supplied nutrient solution separately for each crop.

- Automatic sterilization of the nutrient solution (11) to avoid the use of phytochemicals (plant protection chemicals.
- Fully automated central digital control system-operating by computer (14), monitoring and controlling all the individual parts of the system, and the possibility to on-line control.

This complete and fully automated aeropoinc system of plant cultivation is capable to support, in parallel or not, all known hydroponic or aeroponic growing systems, suitable for any open or closed environment.

Example 2:

Fully automated aeroponic plant growing system, which supports only one single crop with only one nutrient solution needed, as illustrated in Figure(2), consisting of the following parts:

- Only one main container (2), into witch automatically prepared the nutrient solution for only one single crop, by fulfilling by water and the appropriate quantities of nutrient elements from the separate stock solution containers, with automatic control adjustment of pH and conductivity.
- At least two separate reservoirs (1), containing the individual stock solutions of nutrients and the acid solution to adjust the pH.
- Automatic preparation of all the nutrient solutions (3), according to the needs of the crop, with automatic adjustment of pH (10) and conductivity valu (11).
- Automatic temperature control (8) in the root growing space, into the channels or trays by adjusting the nutrient solution temperature into crop reservoir(9).
- Automatic sterilization (9) of the nutrient solution in the main container to avoid the use of phytochemicals. -Growing channels or trays (5), of various shapes or forms, for flat or vertical cultivation, into which the root system of the plants is developed. These channels or trays are made from expanded polystyrene or other suitable insulating material.
- Automatic irrigation system, providing the nutrient solution by pumps(4), transport pipes and sprayers or sprinklers, spraying or misting under pressure (high or low) directly to the root portions into the growing channels or trays, with automatic setting of time and frequency of mist provision. The system recirculates the nutrient

solution from the growing channels or trays back to the crop tanks via rec tanks (6) and return pumps (7), or by natural flowAutomatic irrigation - transport.

- Fully automated central digital control system-operating by computer (12) and the possibility to on-line control.

CLAIMS

1. A fully automated aeroponic plant growing system, characterized in that it allows simultaneous multi-function support crops of various plants with different nutritional requirements, or to support many different nutritional treatments in the same plant species. The nutritive solution is prepared for each culture at the central reservoir and transferred to the individual crop reservoirs and then through a pump and spray system in plants. In case of a single crop species, the nutrient solution is prepared or automatically enters the ready single central container to be transferred to plants.

2. A fully automated aeroponic plant growing system according to claim 1, characterized by automatic control and regulation of the root zone atmosphere temperature, into growing containers or trays, which is achieved by adjusting the temperature of the sprayed or misting nutrient solution to the roots so that it retains the excellent levels of growth requirements of plants, separately for each crop type and regardless of the temperature prevailing in the external space.

3. A fully automated aeroponic plant growing system according to claims 1 and 2, characterized by its growing channels or trays of various shapes and forms, into which the developed root systems, are made entirely from expanded polystyrene or other suitable insulating material.

4. A Fully automated aeroponic plant growing system according to claims 1, 2 and 3, characterized by its automatic sterilization of the nutrient solution to avoid the use of pesticides.

5. A fully automated aeroponic plant growing system according to claims 1, 2, 3 and 4, characterized by its single automatic central computer control system-operation of all the individual parts and the possibility to on line control.

6. A fully automated aeroponic plant growing system according to claims 1, 2, 3, 4 and 5, characterized by its parallel support or not to all known hydroponic and aeroponic cultivation systems, suitable for any open or closed environment.

Figure 1

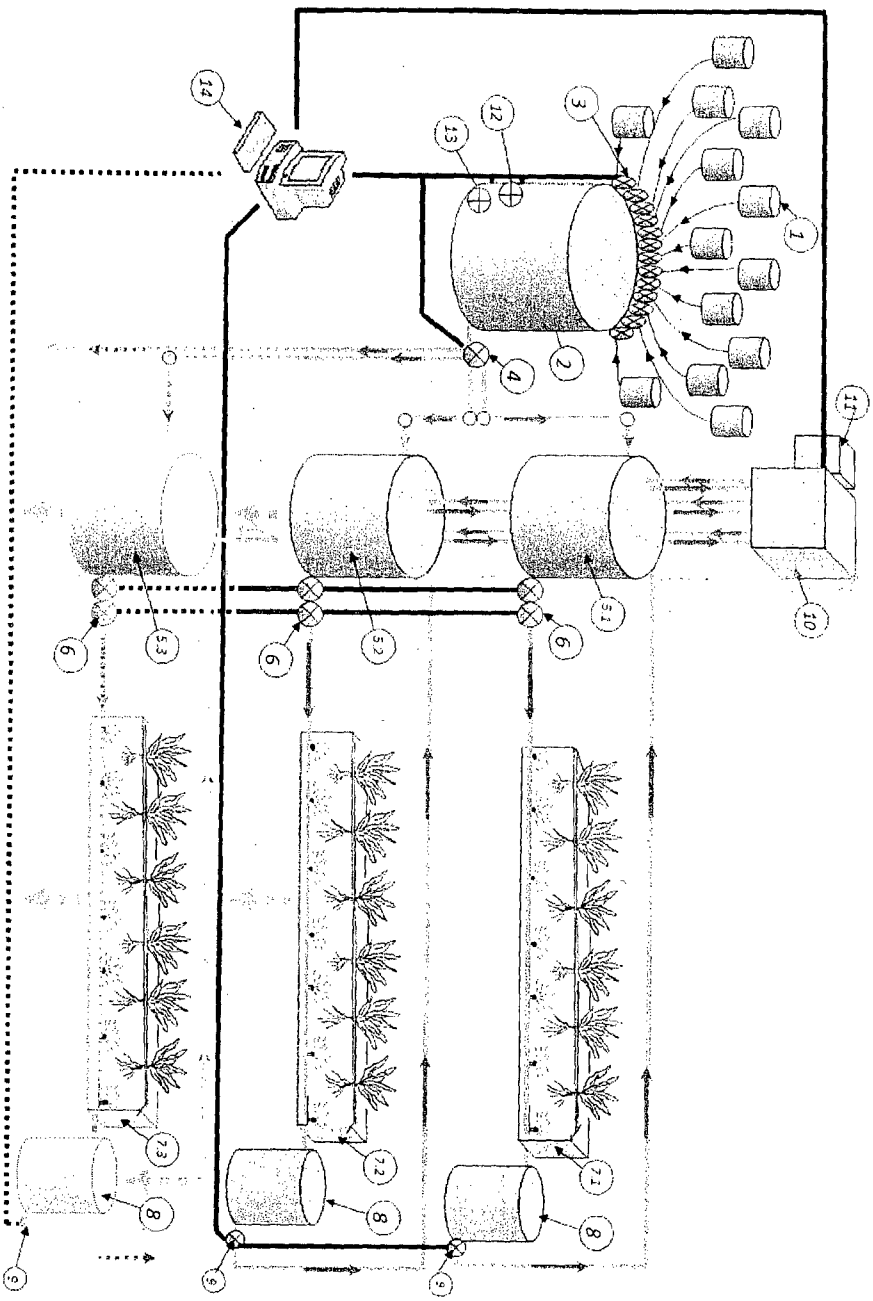
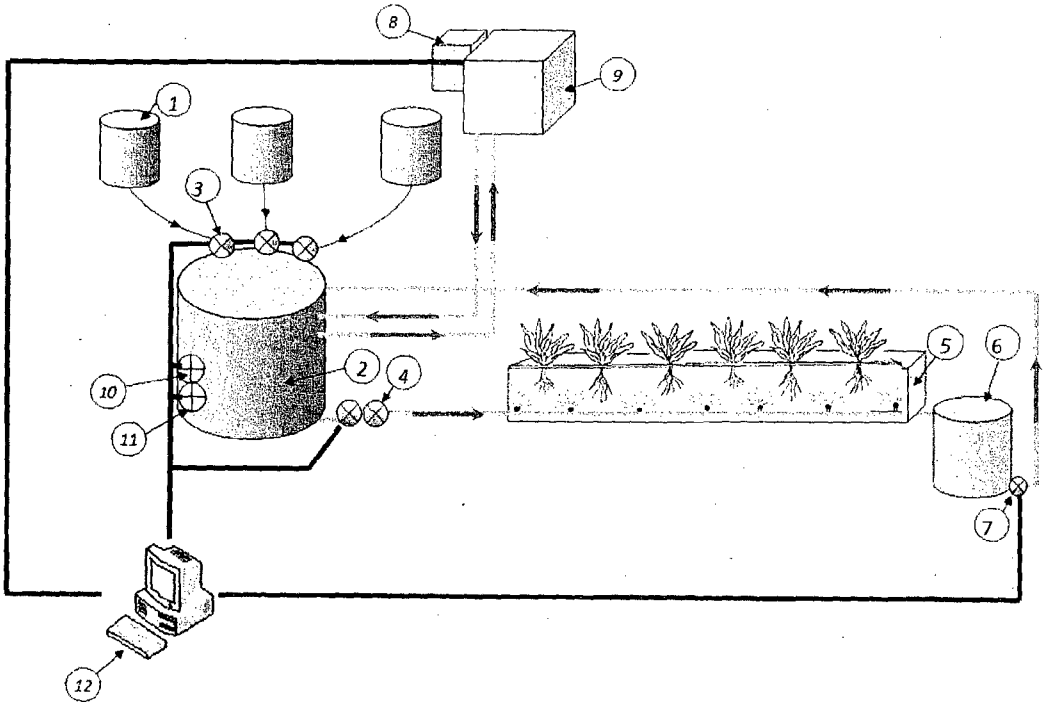


Figure 2



INTERNATIONAL SEARCH REPORT

International application No
PCT/GR2013/000069

A. CLASSIFICATION OF SUBJECT MATTER
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ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A01G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal , WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
8 Apri l 2014	15/04/2014

Name and mailing address of the ISA/	Authorized officer
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International application No
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Information on patent family members

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