CLAIMS

1. A soilless growing system comprising one or more grow modules, each grow module comprising:

an enclosable volume having an interior configured to receive at least one plant in a removeable crop holder in a removable grow bed, the grow bed and crop holder configured to permit growth of the plant therethrough; and

artificial lighting configured to provide light energy to the plant,

a nutrient module configured to supply and condition an aqueous nutrient solution to the grow module; and

a HVAC module configured to supply and condition a gaseous environment to the grow module, the HVAC module configured to supply carbon dioxide into the interior of the grow module.

2. A soilless growing system according to Claim 1, in which the grow module is air-tight and optically opaque; and in which the grow module is formed as an elongated square bifrustum, triangular bipyramid, cuboid, rectangular cuboid, pentagonal bipyramid, hexagonal bipyramid or any suitable polyhedral shape.

3. A soilless growing system according to Claim 1 or 2, in which the grow module is divided into an upper volume above the grow bed which permits growth of the plant, the upper volume having an optically reflective internal surface, and a lower volume beneath the grow bed into which the roots of the plant are periodically sprayed with the aqueous nutrient solution, the lower volume comprising a sealing liner attached to the side walls thereof, in which the sealing liner collects and returns excess aqueous nutrient solution to the nutrient module via an outflow; in which a section of the upper volume of the grow module immediately above the grow bed and which extends perpendicular to the plane of the grow bed in a vertical direction allows the grow bed to be removable by lifting it in a generally vertical direction first before moving it in a lateral plane, in which the vertical height of the grow module is at least the same, or higher, than the width of the grow module in order to accommodate and permit unobstructed growth of a range of plants above the grow bed and the roots below the grow bed; and in which the grow module comprises a door assembly configured to provide access to the upper volume thereof, the grow module and door assembly being covered by a thermally-insulating layer.

4. A soilless growing system according to Claim 3, in which the grow module comprises one or more sensors disposed therein for monitoring the grow module and/or plant growth, the one or more sensors selected from the group consisting, but not limited to, any one of the following: temperature sensor, humidity sensor, pressure sensor, carbon dioxide sensor, digital image capture, light sensor, airflow sensor, and combinations thereof, the output of the sensors being sent to a processing means configured to monitor and control plant growth by controlling the artificial lighting, the nutrient module and the HVAC module.

5. A soilless growing system according to Claims 3 or 4, in which the grow bed is situated upon a weigh frame and one or more load sensors disposed in the lower volume thereof, the one or more load sensors being configured to monitor the mass of the grow bed, the output of the one or more load sensor beings sent to the processing means; and in which the roots of the plant are periodically sprayed with the aqueous nutrient solution via one or more impingement nozzles disposed in the lower volume of the grow module, the impingement nozzles being configured to provide a wide-angled spray pattern.

6. A soilless growing system according to Claim 3, 4 or 5, further comprising an upper air circulation interface being situated above the grow bed, and an opposite lower air circulation interface being situated below the grow bed, the air circulation interfaces conveying the gaseous environment through the grow module and enabling circulation beneath the plant canopy and enable extraction and/or supply of airflow beneath the canopy via a perforated grow bed; and in which the perforated grow bed being configured to allow airflow through the grow bed using channels disposed within the grow bed in fluid communication with conduits attached to the side walls of the lower volume to extract or supply air from, or to, the grow bed via the lower air circulation interface.

7. A soilless growing system according to Claim 1, further comprising one or more plant holders positioned in, and extending completely through, the grow bed, the plant holders configured to hold plants, in which the roots of supported plants are exposed to the aqueous nutrient solution.

8. A soilless growing system according to Claim 7, in which the plant holder being annular in shape having a centrally-disposed opening that extends completely therethrough, the opening being generally square-shaped in cross section from above for receiving a foam substrate configured to provide structure for plants to root into, plants rooted in the foam

substrate having roots that grow downwards and extend into the lower volume of the grow module, the centrally-disposed opening having a sloped inner edge to prevent the substrate from falling through the opening when in use, the plant holder having a collar which seats inside receiving apertures disposed in the grow bed; and in which the foam substrate comprises a cuboid-shaped body portion having a concaved top surface and a slit running through the vertical height thereof, the concaved shape supports one or more seeds and a nutrient mixture droplet thereon, such that when the seed germinates a second foam lid is situated on top of the body portion to cover the nutrient droplet from incident light.

9. A soilless growing system according to Claim 7, in which the plant holder being constructed of one or more pieces which, when combined, create an overall annular shape, with an outer shoulder for locating the component pieces, having a centrally-disposed opening that extends from the upper surface of the holder to a central cavity within the holder; the cavity comprising an concaved lower face, promoting liquid pooling, with a centrally-disposed concaved recess, to locate and prevent seeds from escaping from one or more radially-disposed openings that extend through the lower surface of the inner cavity, and that permit the ingress of fluid; and in which the plant holder being constructed of a flexible unabsorbant material that exerts a compressive force, providing a point of anchoring, on the plant stem that protrudes through the upper centrally-disposed opening and allows the plant's roots to part the lower face of the inner cavity via the one or more radially disposed-openings.

10. A soilless growing system according to Claim 7, 8 or 9, in which the assembled plant holder is receivable in an annular carrier which seats inside a receiving aperture disposed in the grow bed, the carrier having engagement means for ease of transport and/or having a perforated elongate structure for supporting the growing plant.

11. A soilless growing system according to Claim 1, in which the nutrient module comprises:

an nutrient reservoir in which the conductivity and pH are monitored;

fresh water, nutrients and pH regulators and combinations thereof being supplied to the nutrient reservoir using dosing pumps; and

a diaphragm pump configured to pressurise an intermediary storage vessel which enables the pump to operate intermittently or periodically, such that the aqueous nutrient

solution is supplied which is nutrient-rich and contributes to the growth of plants in the soilless growing system.

12. A soilless growing system according to Claim 11, in which the diaphragm pump regulates the pressure between around 4 bar to around 6 bar; and in which excess aqueous nutrient solution is returned via the outflow in the grow module and/or condensate run-off from the HVAC module is returned to the nutrient reservoir under gravity, this returned solution being passed through a filter trap before entering into the nutrient reservoir.

13. A soilless growing system according to Claim 1, in which the HVAC module being operative to supply a treated gaseous environment to one or more grow modules, in which the treatment is selected from the group consisting, but not limited to, any one of the following: filtration, ventilation, heating, cooling, humidification, pressurisation, carbon dioxide concentration, and combinations thereof; and in which the HVAC module comprises:

a fan for inducing air flow between inlet and outlet headers, an outdoor air damper/valve for controlling an inflow flow rate of fresh air introduced into a supply air duct, an exhaust damper/valve installed on an exhaust duct for discharging air from the one or more grow modules, a circulating air damper/valve installed to control the flow rate through a conditioning bypass line;

a carbon dioxide supplying device for adding carbon dioxide to the air circulated through the one or more grow modules;

a humidifying device for humidifying the air circulated through the grow module(s); and

a hot/cold water coil for heating or cooling the air circulated through the one or more grow modules.

14. A soilless growing system according to any preceding claim, in which each nutrient module and HVAC module is each connectable to a plurality of grow modules.

15. A soilless growing system according to any preceding claim, in which the modules are supported in a modular racking which comprises a generally horizontal spanning member, the ends of the horizontal spanning member being receivable between pairs of vertical frame members which include a module support arm configured to support a mounting point disposed on the grow module, the modular racking being longitudinally extendable into aisles and configured to stackably support one or more other assembled racking layers above and/or

below itself within the system; and in which the assembled racking is placed on wheeled trolleys enabling movement thereof.

16. A soilless growing system according to any preceding claim, further comprising one or more elevating devices to automatically move the grow bed between horizontally and/or vertically-spaced modules and/or to and from a processing area.

17. A soilless growing system according to any preceding claim, further comprising an automated soilless growing optimiser comprising one or more computer processors having instructions written in software, in which the instructions, when executed by the one or more processors, cause the processor to perform operations comprising:

performing a plurality of experiments for growing a plant, each experiment controlled by a recipe from a plurality of recipes that identifies parameters for growing plants;

obtaining a machine learning model by training a machine learning algorithm using the experimental results; and

creating, by the machine learning model, a new optimised recipe for growing a plant.

18. A soilless growing system according to any preceding claim, further comprising an automated load-scheduling system which comprises one or more computer processors having instructions written in software, in which the instructions, when executed by the one or more processors, cause the processor to perform operations comprising:

delay, bring-forward, shorten and/or extend scheduled automated activities of the system sub modules/units including but not limited to; photoperiods, cleaning operations, pressurisation and/or aisle movements; and

optimise the economy/efficiency of any such actions to assess the detriment to the crops and advantage of meeting a configurable/settable load/power-demand profile based upon historic data; and

thereby creating an optimised strategy for operation of the soilless growing system.

19. A method of growing plants in a soilless growing system, the method comprising the steps of: seeding a grow bed; germinating the seeds; growing the plants; and harvesting the plants, the plants being seeded, germinated, grown and harvested on the same grow bed within a soilless growing system according to any preceding claim.

20. A method according to Claim 19, in which the plants are grown without a substrate.