

AUTOMATION OF VERTICAL GROWING SYSTEMS FOR GREENHOUSE PRODUCTION IN CONTROLLED ENVIRONMENT AGRICULTURE

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ABSTRACT. Food production is sensitive to supply chain fluctuation, weather condition and climate change. To provide more reliable solutions to food security, the Controlled Environment Agriculture (CEA) was developed. CEA is an advanced and intensive form of hydroponically based agriculture where plants grow within a controlled environment to optimize horticultural practices. Automation of existing CEA solution for greenhouses was designed and tested for different crops, lighting efficiency and cooling system were improved for ZipGrow™ Tower vertical growing platform for greenhouses.

KEY WORDS: Controlled Environment Agriculture (CEA), ZipGrow™ Farm Wall, Greenhouse Racks, Vertical Growing Systems.

Introduction. Greenhouse growing has been around for ages, but there is an ongoing process to maximize yields. ZipGrow Inc developed vertical farming systems for greenhouses (Fig.1), which use ZipGrow™ Tower technology and allow to grow 5-6 times more produce than traditional horizontal growing methods.

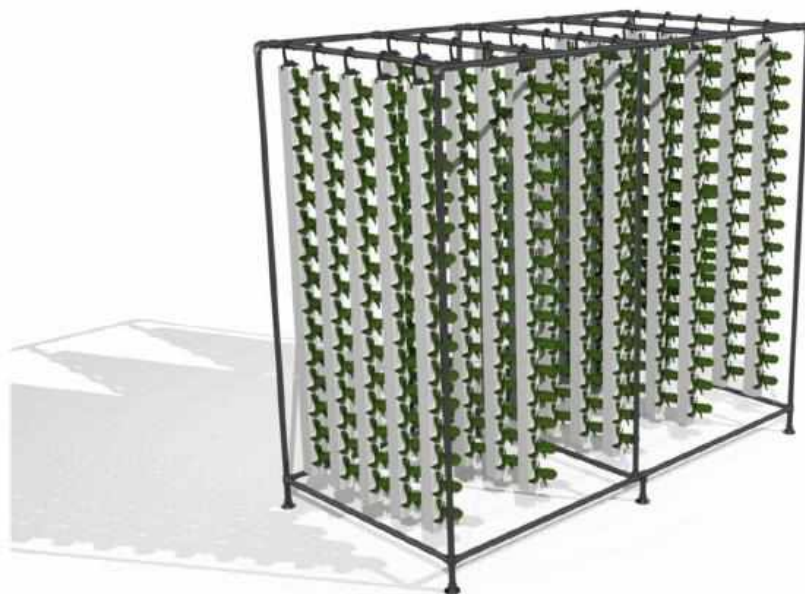


Fig.1 ZipGrow Inc Vertical Farming Systems for Greenhouses

The true vertical growing platform with ZipGrow™ Towers provides unparalleled space-use-efficiency. The systems optimizes space and production by growing vertically on a vertical plane. Growing on a vertical plane also allows for easier access to plants to check for nutrient deficiencies and pests. The ZipGrow™ Towers optimize every aspect of the growing process and increase production per square foot.(Fig. 2)



Fig.2 Unparalleled space-use-efficiency of ZipGrow™ Tower vertical growing platform

While the developed platform solves problem of space and productivity, the following issues for the greenhouses were raised by the local greenhouse operators:

- Existing glass greenhouse has modernized heating equipment, but temperatures sometimes exceed realistic temperatures for vertical crops such as strawberries in modern greenhouses.
- Crops such as strawberries require moderate temperatures to achieve consistent year-round production of high quality,
- Light in the warehouse is spread unevenly, which can affect the quality of the photosensitive crops such as berries.
- Harvesting automation and labour saving are required.

Theoretical and experimental research:

ZipGrow Inc performed research and development using the greenhouse of Kemptville Campus Education and Community Centre.

1) To achieve optimal and consistent temperature mode different cooling systems were tested;

2) Additional light for the photosensitive crops was provided by the combination of ZipGlow LED lights and implementation of the Belt Conveyor designed to operate ZipGrow Towers. Data with the regards to the belt conveyor speed, planting densities, light readings and irrigation frequencies in crops such as strawberries, basil, tomatoes and peppers was collected and analyzed;

3) Designed to operate ZipGrow Towers Belt Conveyor was tested to get realistic yields and labour savings on 5 crops (Strawberries, Peppers, Tomatoes, Basil, Brassica Mix).

Results of research and development.

ZipGrow Inc research and engineering team implemented the Linear Grow Tower Conveyor (Belt Conveyor), which was designed to rotate ZipGrow Towers. Different motor sizing and adapter, irrigation fittings, control circuits and sensors were tested, and the optimal specification was selected. Irrigation system was redesigned for moving system.

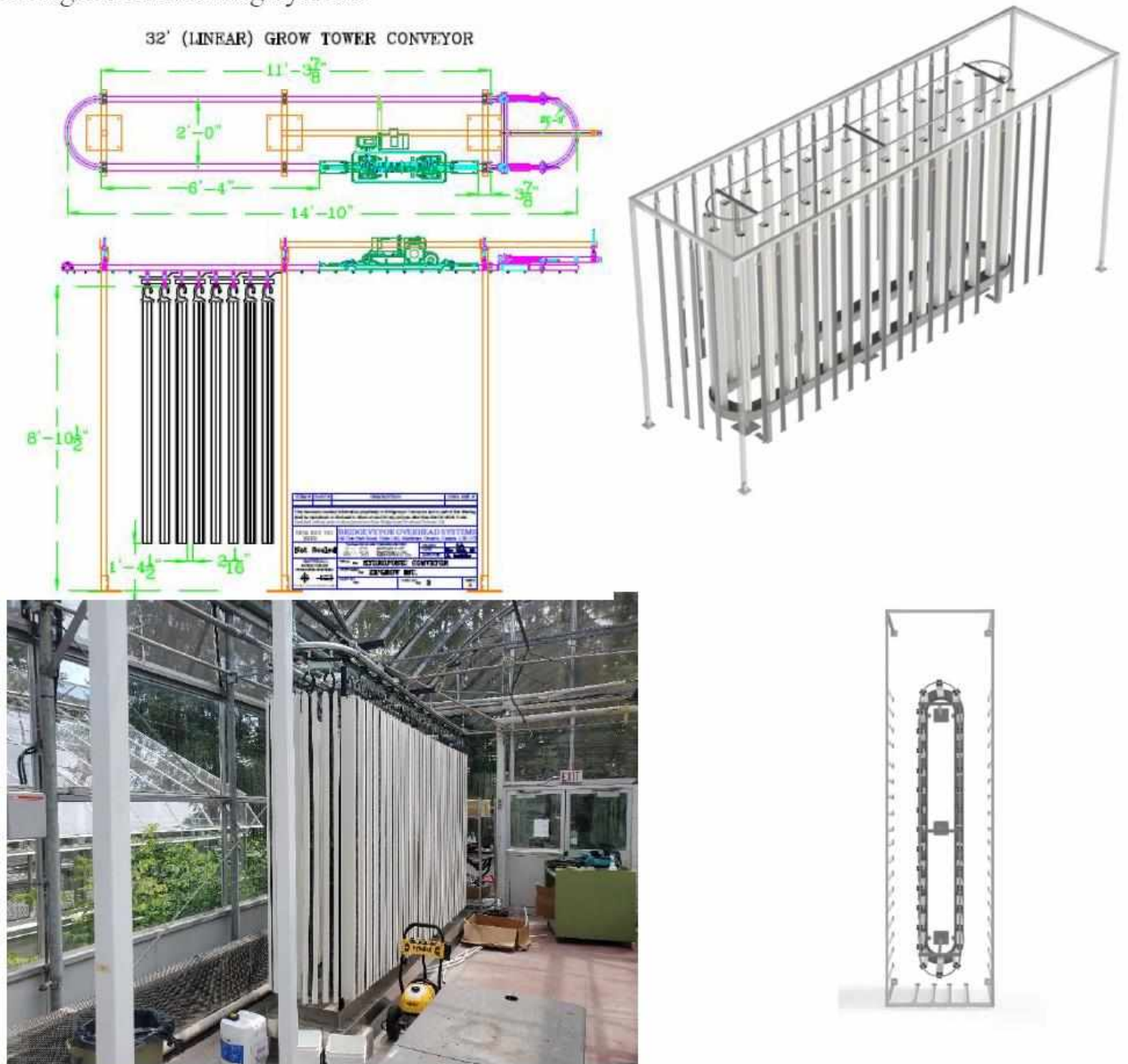


Fig.3. Linear Grow Tower Conveyor (Belt Conveyor)

Rotation of the towers facilitates evenly lighting of the crop and use of natural lighting, when DLI (Daily Light Integral) is high or normal. This allows to decrease cooling and light usage, which leads to the lower electricity consumption and cost efficiency accordingly.

Assembled prototype was in operation for 9 months and proved proper operation of moving parts and reliability of the irrigation system and control circuit. The prototype was tested with the different crops.

Evaporative cooling system was selected as the most cost-effective way to achieve consistent year-round production of high quality, along with liquid shading and increased airflow within the canopy. Adding evaporative cooling updated the greenhouse to the industry standard for production climate.

Trials also were taken place over off-peak seasons for daylength, and the purpose of this system was analysed to provide crops when the Canadian market relies heavily on imports. Prices for fresh produce such as strawberries peak in December, when DLI (Daily Light Integral) is the lowest, therefore supplemental light is necessary to have competitive yields in this market. Additional lighting is required above existing HPS lights, and installation of ZipGlow LED brought the system in line with industry standard for growing the crops and allowed to create comparisons to conventional growing.

The result of the competed research and experiments with the prototype proved labour savings on five crops such as Strawberries, Peppers, Tomatoes, Basil, Brassica Mix.

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ПРАВОВИЙ АСПЕКТ ЗЕМЛЕВПОРЯДКУВАННЯ В УМОВАХ ВОЄННОГО СТАНУ

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За умов воєнного стану в Україні деякі правові норми відносно землевпорядкування зазнали змін відповідно до актуальної ситуації та необхідних вимог сучасного положення.

Таким чином був прийнятий Закон України «Про внесення змін до деяких законодавчих актів України щодо створення умов для забезпечення продовольчої безпеки в умовах воєнного стану» [1]. Він був прийнятий 24.03.2022 та набрав чинності 07.04.2022.