



LemnaTec 3-D Conveyor for Greenhouse Operation

Watering and Weighing Stations

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Introduction

The LemnaTec watering and weighing station is the logical result of LemnaTec´s developments for the comprehensive control and automation of growth conditions.

This appliance controls nutrient and watering conditions either in combination with image acquisition or as a stand-alone module in LemnaTec greenhouse management conveyor systems..

In all cases a barcode reader or an RFID module identifies each pot individually to later assign the measured values and trigger appropriate watering protocols.

Technical Specification

Weighing module

The weighing module consists of an airpressure unit lifting up the potted plants from cars running on a conveyor belt. The integrated balance can then weigh the object with an accuracy of 0,1 g. If barcodes are used, an optional turning unit is able to find codes at any position of the pot. To minimise external influences, e. g. of strong air movement, covering of the weighing area is recommended. The constant weight of all cars allows for reproducible measurements of plants and pots.

Technical specification of the balance:

- ?? Reproducibility > 99 % of total weight
- ?? Weighing range (depending on balance model) between 200–50,000 g
- ?? Rate of measurement: 50 Hz
- ?? Protocols for weighing (damping intensity, number of averaged values) can be user-defined to satisfy all needs
- ?? Balance is tared before every run

Applications

1. As weight loss due to evaporation of water is much bigger than weight accumulation by growth, evaporation rates can be measured by weighing the plants in short intervals, especially when the pot surfaces are closed. These values can be related to leaf area values measured simultaneously.
2. If pots shall be watered up to a certain weight defined by the database, the weights measured before watering are compared to the values in the database, then instructing the pump to deliver the appropriate amount of water. After watering the weight is measured again to control the amount of water delivered.

Watering module

The high-precision watering module consists of a peristaltic pump that can deliver various water or nutrient solution volumes at different flow rates. This allows contamination-free pumping even of corrosive nutrient solutions. Pumps have a high degree of water resistance (IP66).

Technical specification of the pump:

Flow rates: depending on the pipe diameter (0.5–8 mm) and revolutions per minute (0.1–220 rpm), the flow rate ranges between 0.004 ml/min and 1,800 ml per min (e. g. for a specific pipe: 0.004–9 ml/min up to 0.8–1,800 ml/min)

Precision: pumping can be performed with an accuracy down to 0.1 %

The following parameters can be customised to users' needs:

1. Flow rate (user-defined),
2. Range of volume (depending on choice of pipe in the peristaltic pump),
3. Option to draw liquid from different vessels (manual or automatic valve change)
4. Option for user-defined calibration of volume

Control of all Parameters Related to Weighing and Watering:

All actions of the weight and watering station are controlled by the main database of the Scanalyzer 3-D conveyor systems. For each pot the user can predefine the following parameters, either in a simple Excel/csv. file or by direct connection to other databases:

1. Programmed watering times: Watering cycles can be predefined to the exact day of watering. If plants should be watered e. g. twice a day, the earliest hour of watering in the morning and in the afternoon are set. If a pot arrives after this time, it will be watered with the protocol defined. If it arrives again later, but before the next scheduled watering, no water will be delivered. This programmed watering allows free choice of watering protocols to simulate all conditions, from draught to optimum water flow.
2. Continuous watering: A plant can be watered according to the protocol each time it enters the watering station, allowing for example to keep the watering level constant and to measure evaporation based on replaced water.
3. Source of water: If the system contains an electric valve, the source of the water (e. g. pure water or water charged with nutrients) can be defined.
4. Watering protocol for constant weight: Watering up to a certain pot weight predefined in the database keeps the full weight constant. The target weight may be adapted to the growth of plants over time.
5. Watering protocol for constant volume: This parameter is especially suitable for the delivery of nutrient solutions, or if excess water should flow out of the pot again to flush out salts, or if a 100 % saturation of the soil is simulated.
6. Other triggers for watering: Depending on the customer's needs, other triggers for watering can be adapted. This may include the acquisition of

values based on image analysis, e. g. for leaf rolling in drought experiments or conductivity measurements in the soil.

In all cases volumes delivered and weights measured will be stored automatically in the database for future data calculation, e. g. evaporation rates or efficiency of water usage.

Integration of the Weight and Watering Station into the Conveyor System

When a new pot arrives it will be identified by barcode or RFID. To ensure that barcodes are correctly read off, an additional turning device is necessary. Afterwards the database is checked to see if the pot must be weighted and watered. In the next step the pot is weighed and available data in the databases is checked to calculate the right amount of water and the source of the water or nutrient solution to be delivered. After watering, the pot is weighed again. When the whole process is finished, the conveyor belt gets the order to move on. Weighing time takes around 5 to 10 s. Watering time is strongly dependent on volume and flow rate. The maximum flow rate is mainly defined by the amount of water per time that a pot can bear without overflowing or mixing up of soil. Generally, the whole weighing and watering procedure is designed to be shorter than 30 s. This is in the very range of the imaging time so that no additional time is wasted for watering.

For further information please do not hesitate to contact

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