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Nutrient Delivery Systems and Irrigation

Dr. Gene A. Giacomelli
Controlled Environment Agricultural Center
Agricultural & Biosystems Engineering Department
University of Arizona

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Introduction [\(top\)](#)

One of the most important components of a successful crop production system is an effective means of delivering water and nutrients to the plants. This system must provide the right amount of water (with dissolved oxygen and nutrients) to the root zone of the plant at the right time. This "fertigation" must be efficient, uniform, and dependable in order to produce quality crops of uniform size and maturity. Each system is described primarily by the type of hydroponic, soilless culture or water delivery mechanism employed, such as NFT, ebb & flood, and drip irrigation.

Several important characteristics of the watering system include:

1. The nutrient solution transport/flow pattern within the root zone
2. The buffering capacity of the root zone
3. Whether the nutrient solution is recirculated or "drained to waste"
4. The frequency and duration of watering. Frequency and duration of nutrient solution flow are dependent upon the plant culture system, the physiological age, and the water demand of the species under production.

Design Considerations [\(top\)](#)

There are seven major considerations for the design of a water and nutrient distribution system. These include:

1. Nutrient solution preparation
2. Storage capacity
3. Pumping capacity
4. Nutrient solution distribution
5. Nutrient solution recycling

6. Production unit
7. Controls.

Nutrient Solution Preparation [\(top\)](#)

The appropriate concentration and combination of nutrients with an appropriate pH must be regularly prepared. If mixed in advance of use, it must be stored. Typically, proportion mixing units are used for on-demand, automated mixing for drain-to-waste irrigation system such as drip irrigation with soilless media bag or pot culture. The water quality is crucial for successful nutrient solution preparation. Low salinity, near-neutral pH, moderate alkalinity, low mineral content, and the lack of other organic or inorganic pollutants are desirable attributes of water used for preparing nutrient solution. Prior water testing is necessary to determine whether any pre-treatments should be regularly completed before use.

Storage of Nutrient Solution [\(top\)](#)

Storage is necessary for nutrient solutions that are mixed in advance and used for closed water systems such as ebb and flood or NFT systems. The necessary storage volume depends on the size of the growing system (number and type of plants), and the water demand imposed by the local climate. In general, for a small system (less than 500 m² (5000 square feet) of production area), 1 - 2 liters (1/4 to 1/2 gallon) of water per plant should be provided in storage. Pumping frequency and volume should be distributed in time to each plant zone so that the storage tank maintains about 40 - 50% of its nutrient volume during each pumping event.

Pumping Capacity [\(top\)](#)

The design pumping capacity is a function of the:

- size of total system and the number of watering zones
- type of plant and maximum daily watering demands
- type of culture system
- duration of each watering event.

Culture systems with large root zone buffering (water holding capacity) such as soilless media in pots or plastic film bags, should be designed with a minimum pumping capacity of two (winter) and four (summer) watering events per day for the entire production system. However, culture systems with smaller buffers, such as rockwool or NFT, must be designed for many watering events per day.

The duration of watering should be short intervals of only 10 - 15 minutes in length, if watering frequency is once every hour or several hours. However if watering duration is 1 - 2 minutes in length, then watering frequency should be once every 10 - 15 minutes. It is generally better to have more frequent, short duration watering events for most systems which have small plant root zone buffers. Timing and duration of water applications are highly dependent on the environmental conditions, and the crop specie and age.

Nutrient Solution Distribution [\(top\)](#)

A network of piping is required to uniformly and dependably distribute the nutrient solution for growth of a quality crop. The system should be unobtrusive to other systems and be protected from damage, leakage and contamination. The system should be filtered to prevent particles from causing blockage, and non-uniform flow rates, such as, at discharge nozzles. They should be designed for equal pressure losses between pump and each outlet to ensure uniform water flow.

The discharge outlet may be attached to (drip systems with pots), or unattached from (ebb and flood systems with transportable benches) the production container. Additional parts of this plumbing network are: the device for incorporating nutrients, aeration devices, valves and manifolds for zoned watering, and sensors for monitoring flow, pH, conductivity (or individual nutritional elements).

Nutrient Solution Recycling and Return ([top](#))

The collection system of troughs and pipes collect the discharge from the production containers within a closed, recirculating system. The entire nutrient return system should be covered and protected from contamination. Open, non-recirculating systems drain excess water to a location outside of the greenhouse. It is advisable to have a use for this nutrient water, such as irrigation of a field crop, as it may be as much as 0.1 gallon per square foot of greenhouse per day.

Production Unit ([top](#))

The production unit is part of the culture systems, and may range from individual pots to expanses of concrete floors, and may include flats, trays, bags of soilless media (perlite, rockwool, pine bark, etc.), rockwool cubes, stationary or transportable benches, or troughs. The production unit encompasses the root zone of the plant, either individually or connected into groups, such as, trays, or grouped as individuals within larger transport units such as benches or troughs on frameworks. The production unit also includes the crop support, if that is necessary to keep the plant upright (e.g. tomato production).

Controls ([top](#))

The timing (beginning to end of each day; day only; or day and night), frequency (number of events per day), and duration (length of each event) of the watering events should be automatically controlled. The controls may range from simple time clock switches to computer-based monitoring and control systems. The values of the control parameters listed above depend on the crop grown, the age of the crop, the environmental conditions, the growing system employed, and the management practices of the grower.

The controls must be extremely dependable, and should have a means for signaling the grower if a failure has occurred, prior to damage or loss of the crop. There should additionally be a backup control system, or an override to manually trigger a series of watering events.

Questions? ([top](#))

Contact Dr. Gene A. Giacomelli
Agricultural & Biosystems Engineering
504 Shantz, University of Arizona
Tucson, AZ 85721
(520) 621- 1412
giacomel@ag.arizona.edu

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