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Gerbera production – A flower crop model for hydroponic systems

Avoiding salinity is the target*

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Introduction

Presently most gerberas in Colombia are grown in soilless media in containers or bags of four to five liters. The important revolutionary process by which traditional soil-crops become soilless media-crops is still continuing today.

Yet, at the time of transition from soil to soilless media, it was important and essential to change the irrigation systems - used successfully for soil crops - for more suitable systems, already developed for container-grown crops. However, growers simply transferred the conventional irrigation systems (integral drippers of two liters per hour per dripper) as they were, to the new hydroponic systems.

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Salinity is a problem in many Colombian hydroponic gerbera farms

The water-run of these integral drippers is actually a micro flow of joined drops rather than a flow of separated drops. As a result, this kind of joined- drops flow causes fast gravity water movement and affects the rapid downwards movement of water, through only the narrow front of the media. Therefore, the result of short fertigation pulses (*three- five minutes each*), applied by these conventional drippers to soilless media, is uneven wetting of the roots zone, dry or semi dry volumes in the containers, and accumulation of fertilizer salts, expressed in the drainage, by high electrical conductivity (Ec. above 3000-3500 micros.).

This is the practical meaning of the term "Saline conditions".

These "**saline conditions**" act as an obstacle for further development of the Gerbera as a hydroponic crop in Colombia. Salinity surveys of Colombian hydroponic-gerbera farms (March 2004) show that out of 14 farms, ten were under different degrees of salinity, and only in four farms no salinity conditions were identified.

How saline conditions develop

Generally, soil-beds used in the cultivation of intensive greenhouses-protected crops such as gerberas, are well drained and well aerated, these being prerequisites for creating optimal conditions for increased volume of the plant roots.

For this type of raised soil-beds, one irrigation dose per day is the most commonly used technique.

The water dose calculated for this irrigation is the amount needed to wet the roots zone, and for rinsing the excess of accumulated salts below the depth of the most important active-region of the roots zone (0 - 35 cm).

During the growing season, these constant applications of the fertigation amount are responsible for the creation of irregular

Figure 1. Salinity front in soil-beds of gerberas (not normally seen by growers)

"saline front's lines", at the depth-ends of the wetting fronts (**Fig.1**).

It is quite a common practice for gerbera soil-beds, that, on occasion, an extra intensive irrigation dose is given, in order to dilute these saline fronts.

Productivity of intensive crops depends mostly on the quantities of water moved through the plants organs. Generally speaking, the higher the transpiration rates, the higher their production.

Under optimal growing conditions in countries like Colombia, the rates of transpiration of well-established gerbera plants (with 30 – 40 mature leaves) are usually 400 – 600cc / per plant / per day, including evaporation from the media.

With salt-free water, gerberas, like other plants, are able to enjoy the benefits of increased water sources from the media for growth, but in practice, hydroponic-crops are fertigated constantly by injecting fertilizer-salts into the irrigation water (on top of the original content of the water in use). For gerberas, 0.75 – 1.5 gram / per liter is injected with Ec of 1000 – 2000 microS., and a pH of 5.5 to 6.0.

Furthermore, in small soilless media-volumes (*i.e. 4 - 5 liters of raised-containers*), the plants frequently utilize a high percentage of the available water, and at the same time there remains some remnants of unused fertilizers-salts in the media.

This simply means that saline conditions remains a constant threat.

The quantity of fertigated-water (*300 - 400cc / per plant / per day*), given in most of the Colombian hydroponic-gerbera farms, via conventional dripping systems, is less than the average-daily evapotranspiration rates.

Figure 2. Roots of young gerbera plant grown on cocopeat media with optimal growing conditions: fertigated with 1600cc / per day divided into six irrigations (throughout 40 minutes per irrigation), and drainage of 60 – 65%.

Furthermore, in most cases, the growers tend to illogically divide these too small daily amounts, into three or more short pulses (*3-5 minutes per single irrigation*).

In such short pulses of (*50–150cc*), water does not move uniformly throughout the media volume, therefore one side of the bag below the dripper is partly wetted, while the rest of the bag volume is semi dry and salty, a condition that eliminates root growth.

This non-balanced situation and the use of unsuitable irrigation systems by the hydroponic-gerbera farms in Colombia are the main causes for accumulation of fertilizer salts in the root zone, as well as in the plant organs**.

Avoiding the ongoing problem of salinity

The gerbera as an intensive modern crop prefers rich feeding formulas***.

Nevertheless, this fact does not change the gerbera to a **salt-tolerant** plant. Moreover, the nature of the gerbera species is that all the sensitive morphogenesis actions, i.e. the development of new adventitious roots, the development of new branches, leaves, growing buds and flower buds, all take place at the soil surface level, a very sensitive zone regarding dryness, salinity, heat / cold, light, etc.

Therefore, saline conditions are risky in any place in the media volume.

It is appropriate to state that in soilless media, the goal of fertigation, in addition to feeding functions, is to avoid any possibility of damaging the root system by salinity fronts.

Creating optimal growing conditions for the roots

Water movement through the plant organs starts and depends on the presence of active

*** Under saline conditions, macro elements accumulate in the leaves and can easily be analyzed from the petioles. This is usually about 200 to 250 % of the normal rates for N, K, Ca, and Cl.*

**** Bibliography average-recommendation for feeding hydroponics gerberas*

N – 160, P – 40, K – 215, Ca – 120 (ppm) roots tips. Thus, it is essential to create in the volumes of soilless media the "Optimal growing conditions", from the topmost surface to the bottom of the container (**Figs.2, 3**).

If growing conditions in the containers are prevented from reaching their optimal range, the plants will not achieve their potential production and quality.

The gerbera roots system and its reaction to salinity

For hydroponic gerberas, the quantity of young fresh active roots, the density of these roots and the distribution of the roots throughout the container volume are all significant for the continuity of flower production.

The gerbera roots system is composed of two root-types:

1. The adventitious roots, connecting the plant to the ground, which remain active for very long time (more than a year under optimal growing conditions, see **Fig.3**). The adventitious gerbera roots are formed only on young stems located just below and close to the surface of the soil in the media. They are thick and do not split.

2. The thin-branched roots (see **Fig. 2**) are formed only on mature adventitious roots. They are responsible for the water uptake via the root tips, thus they branch and grow continuously, (*also known as the secondary roots system*).

For the newborn roots, and for their first phases of elongation, this particular location is a very sensitive zone, regarding possible saline conditions, dryness, high or low temperatures, etc.

When severe saline conditions develop, the growth of the young adventitious root-tips and the secondary roots tips will probably be impaired, and their elongation process will cease.

As a result, formation and growth of the secondary roots will be extremely limited.

Consequently, existing roots will turn brown and will burn too.

At this stage, without enough active vivid roots the plants leaves and the flower stems will display wilting phenomena.

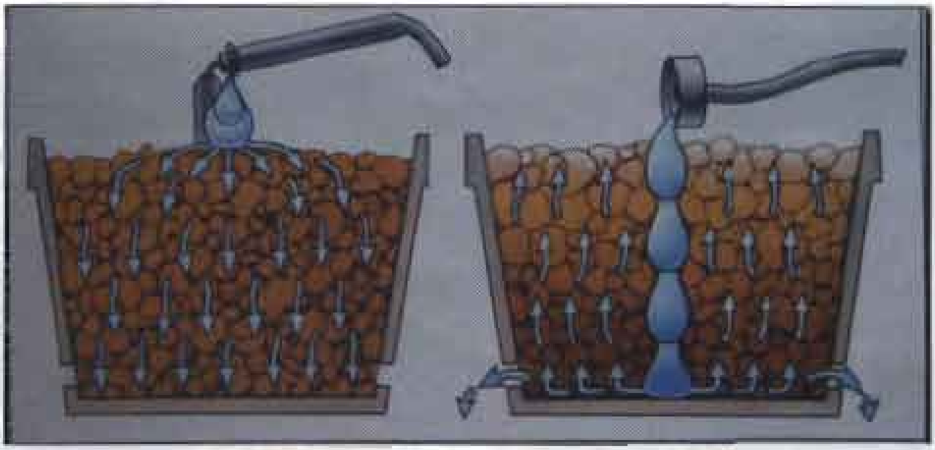

Table 1. Illustration showing characterization of micro and conventional irrigation systems

The reaction of the leaves and the flower stems to salinity

It often occurs that growers do not identify the gradually developing salinity problem on time.

Therefore, growers should be made aware of the salinity phenomenon, and of the know-how to prevent it. Early identification of salinity phases will save a lot of trouble.

Figure 3. Roots of well developed four-year-old gerbera plant, grown on cocopeat media, fertigated seven times a day with recycled drainage water, 1700cc / per day, and drainage of 65 – 70%.

The degrees of salinity damage in gerberas grown in hydroponics are as follows:

- Browning and burning of the roots
- Difficulty in water uptake
- Flower stems become shorter
- Flower diameter is reduced
- Minerals accumulate in the leaves, the leaves loose their flexibility, become hard and brittle
- Sensitivity to diseases increases
- Weakening of apical dominance
- Development of vegetative buds

Plant recovery may take weeks or even months, depending on the stage and the rate of the damage, and the time needed for the roots to refill the container volume. Early discovery and immediate reaction will shorten the recovery duration. An advised method for discovering root damages is to grow some model plants in rigid plastic containers. Taking out and exposing the roots systems for examination helps to identify damage.

When salinity is discovered, flushing should be carried out immediately.

Practically speaking, if the plant recovery process takes a long time, the process of washing out the accumulated salts from the media is easy and short, just by applying one long dose of fertigation.

Only after this stage, the growth of new roots is able to renew. Immediately after flushing, fertigation schedules should

Figure 4. Optimal results in hydroponic gerbera farm in Colombia, Cultivar Rodrigo

continue normally.

Some necessary questions

At this stage, hydroponic-gerbera growers should ask the following questions:

Why in Colombia, despite the available excellent water qualities and the excellent climatic conditions available for Gerbera production, are saline conditions gradually being built up, and why, in the second year of production, are saline conditions increasing even faster?

What is wrong with the approach and understanding of the hydroponics systems they choose?

It is recommended that gerbera growers carefully examine the following:

- The irrigation system and its control
- The daily amount of water needed
- The timetable for irrigation doses
- The duration of a single irrigation dose
- The soilless media type
- The container volume
- The container type and size
- The location of drainage-holes and their total surface
- Future possibility of recycling the drainage water, etc.

The right practical answers to these kind of questions will lead the growers to practical solutions to create "optimal growing conditions" to avoid saline conditions in their farms.

Optimal growing conditions for the roots system depends mainly on correctly wetting the limited growing-media volume, and irrigating the container volume according to the water tension of the media. And this is only a technical and economic issue.

Changing the irrigation systems

It is possible to create "optimal growing conditions" in the root zones by operating drip systems that apply small quantities of water (*200–500cc / per hour*), five to seven times a day, in durations of thirty to forty minutes per single irrigation, applying it in a total duration of two hundred to two hundred and eighty minutes of irrigation per day.

An irrigation regime such as this will allow slow water movement, both laterally and vertically throughout the media, wetting it uniformly, washing excessive salts and supply maximal amounts of Oxygen to the roots (**Table 1**).

Decreased water flow, (i.e. intervals of one to three and more seconds between the fertigated drops) creates a positive balance between the capillary water movement and the gravity water movement. Thus, uniform humidity in the container's roots zone, reflects the uniformity of salt concentration in the media, and as a result, the drainage qualities represents more accurately the Ec and the pH conditions of the entire root zone.

The purpose of drainage

The purpose of drainage is to flush out the excess salts from the media, accumulated during the evapotranspiration process.

Rapid and effective drainage also acts as a form of air suction into the roots zone. Therefore it is essential to carry out drainage no longer than 10-15 minutes after irrigation has ended.

Rapid and effective drainage is achieved by using relatively tall containers (22cm) having large drainage-holes (*2500 to 3000 mm^2 for 4 liter containers*), located only on the bottom and at the lower sides of the container.

Superior results achieved

Salinity has been avoided in some Colombian hydroponic gerbera farms, where irrigation of 800 to 1000cc of water / per plant, is given in four or five irrigation doses a day (*200-250cc per single irrigation*), using two drip emitters per bag.

These irrigation doses, running for 25 to 30 minutes of continuously protracted dripping, are recommended to eliminate the danger of salinity, to allow activity of the roots at the entire container volume, to allow continuity of growth and flower production, to create high strong stems with high quality flowers, and even to reduce Botrytis damage (**Fig. 4**).

Using accurate control appliance for accurate irrigation

Avoiding salinity in hydroponics should become a daily practice.

In hydroponic farms (big or small), it is almost impossible, without the use of electronic appliances, to control optimal water tension in the growing media at the optimal range for optimal roots growth, or to control drainage qualities and quantities.

Accuracy of irrigation (*timing and quantities*), can be achieved by using an "electronic-tensiometer" - a device that measures the water tension in the media (in millibars), and controls the irrigation via irrigation software.

Accurate irrigation-timing during the day and the night, means following and reacting on time to changes in water tension in growing media, as the outcome of water consumption by the plants plus the evaporation from the media surface.

One electronic tensiometer, stationed on the upper third part of the media of a gerbera-grown container, can accurately control and irrigate an area of about 40,000 plants and more.

To avoid saline conditions for optimal root growth and drainage, the advisable water tension boundaries (between the highest figure advised to begin the irrigation, and the lowest figure when irrigation ends), are quite narrow.

For cocopeat media, for example, it lies in the range of 8 to 4 millibars, no matter what the real highest figure is.

To sum up, saline conditions in soilless media used for intensive hydroponics crops, is a persistent threat. Yet it is possible to avoid and to overcome, even by non-experienced hydroponic growers.

Taking measures to control and avoid salinity in soilless media

- Operate fertigation cycles, in response to the evapotranspiration rates of the plants.
- Operate electronic tensiometers to measure the changes of the water-tension-course in the growing media accurately and instantaneously.
- Operate micro-irrigation systems according to the changes in the water tension in the media.
- Constant control of the quantities and the qualities of drainage.
- Constant examination of the roots system, the foliage and the flower qualities.
- Program the above information needed for creating optimal growing conditions.

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