Greenhouse Media and Fertilization

Greenhouse media used in the industry today varies from soil to soilless mix which creates problems when understanding the status of plant available nutrients for plant uptake.

The variation in growing media also creates problems with drainage, aeration, and buffering capability of the various materials. Add to this the complexity of the crops that we produce in this material and the impact that these plants have on pH and EC of the various materials. In the case of flowers the ideal pH range to grow certain flowers is well documented, and it is also proven that these same plants will alter the substrate pH to a point where it is then detrimental to the growth of the plants. In production systems such as this it is important to monitor and regulate the pH of the media.

Table 1. suggested substrate pH ranges for specific greenhouse crops grown in soilless media. For crops not listed, the recommended pH range is 5.4-6.2.

Species	pH	Why
Celosia	6.0-6.8	Prevent Fe & Mn toxicity
Dianthus	6.0-6.8	Prevent Fe & Mn toxicity
General Crops	5.4-6.8	pH tolerant
Geranium	6.0-6.8	Prevent Fe & Mn toxicity
Marigold (African)	6.0-6.8	Prevent Fe & Mn toxicity
Pansy	5.4-6.8	Prevent B & Fe deficiency, avoid Thielaviopsis
Petunia	5.4-6.8	Prevent B & Fe deficiency
Salvia	5.4-6.8	Prevent B & Fe deficiency
Snapdragon	5.4-6.8	Prevent B & Fe deficiency
Vinca	5.4-6.8	Prevent B & Fe deficiency; avoid Thielaviopsis

Other nutrients are also less available when the pH moves outside these ranges and availability to the plant is restricted. Therefore it is very important to address pH of the media before planting the crop.

Plants also have the ability to adjust the pH of the media they are grown in and in some cases if the media does not have the buffering capability such as many soilless media, the pH may move outside the ideal range. For this reason it is important to monitor the pH as well as the EC of the media on a regular basis to avoid problems. The general pH for bedding plants in soilless media is between 5.4 and 6.8. It is recommended that it be maintained between 5.6 and 6.2. Poor uptake of nutrients, particularly boron, copper, iron, manganese, and zinc occur if the pH of a media is above 6.5. However in some cases this may not provide enough calcium and calcium may need to be added to the system in a form that will not raise pH.

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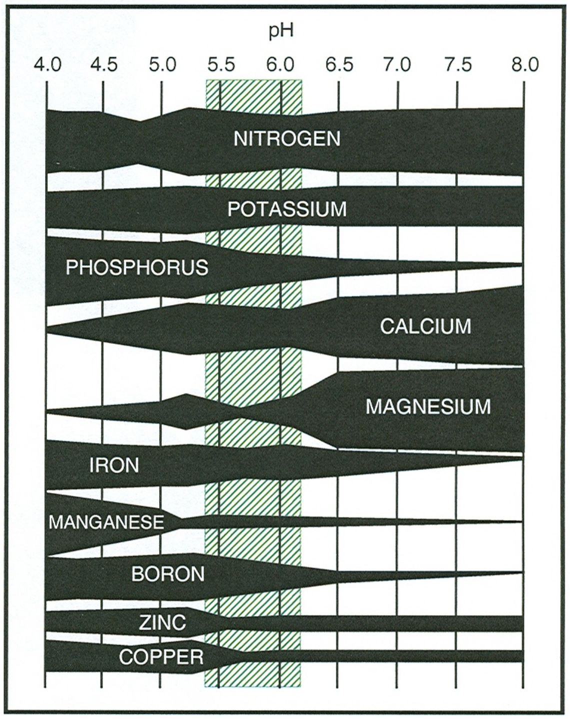
Chart 1. Influence of pH on the availability of essential nutrients in a soilless media. The pH range recommended for most crops is in the shaded area.



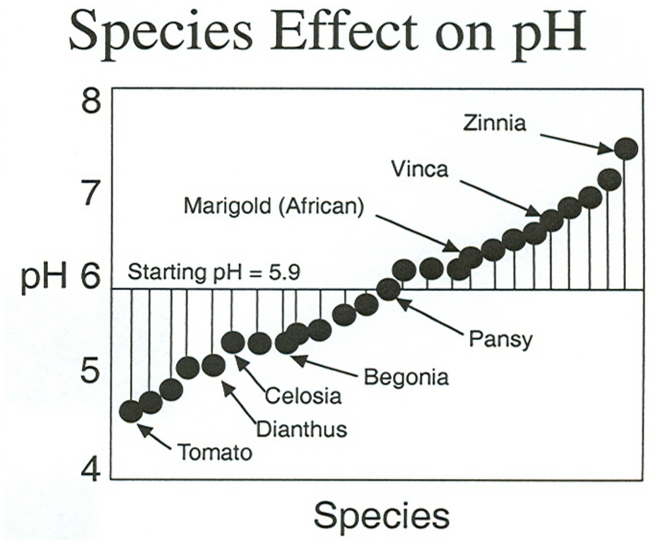


Figure 10. Effects of 25 bedding plant species on substrate pH.

Regulation of the pH of media is therefore very important and we need to establish a pH base line as suggested in Table 1. Next upper and lower "decision points" must be determined for each species. Decision points are limits that determine when action must be taken to correct or prevent an out-or-range pH. The final stage of a pH stabilization strategy is to decide how to control pH in your particular production system, then monitor frequently to assure that you are within the acceptable pH range for each of your crops.

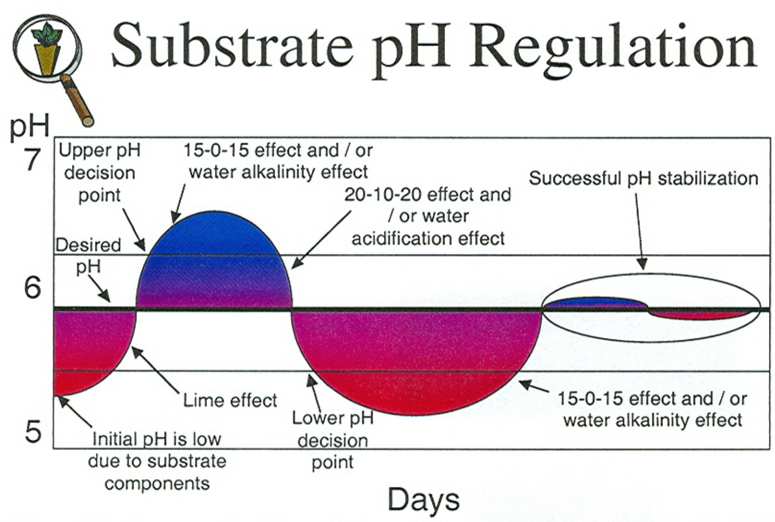


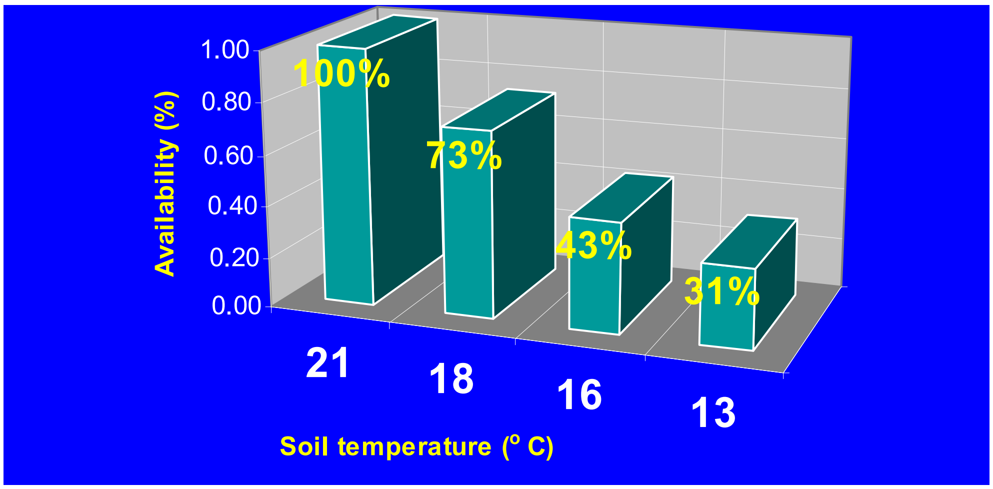
Figure 11. An example pH regulation strategy based on a desired pH of 5.9.

Nutrient Antagonisms:

When certain elements are provided in excess to plants, uptake of other nutrients may be hindered. One example of a mineral antagonism is the nitrogen-potassium interaction, where for most bedding plants a 1N:1K ratio is recommended. Other types of antagonisms are the potassium-magnesium-calcium interaction. For this reason A&L soilless media test addresses the three cations in melliequivalents with a targeted ratio that should be aimed for. Due to the uniqueness of different soilless media balancing Mg and Ca is critical.

Temperature of the media also has an impact on nutrient availability. One classic example is the effect of low temperature (<55 degrees F) on the uptake of phosphorus in tomato. Purpling of the lower foliage is the common symptom. Geraniums also can express phosphorus deficiency when they are grown too cool in the spring.

Phosphorus availability for plant uptake at different soil temperatures



Nitrogen Rates and type of nitrogen

Once the frequency of fertilization has been decided the next decision is the rate of nitrogen to use. This in not as difficult a decision as it might appear to be. Aside from plug seedlings, the concentration of nitrogen ranges form 240 to 720 ppm (1 to 3 lbs of 20% nitrogen fertilizer per 100 gallons) when applied weekly and 90 to 225 ppm when applied with every watering. Once a crop is categorized into a very light, light moderate, heavy, or very heavy fertilization category it is easy to assign a rate to it. Table 2. lists concentrations of a 20% nitrogen fertilizer to be used for weekly fertilization and for fertigation (with every watering) for various crops.

Ratio of Potassium to Nitrogen

Most crops develop best on a fertilizer equally balanced in nitrogen and potassium. There are a few exceptions. The Elatior begonia grows faster and develops more side shoots when it is fertilized with a ratio of 2 parts nitrogen to 1 part potassium (Table 3). The Azalea requirement is similar in that a 3:1 ratio is best. The carnation requirement is quite different since a ratio of 2 parts nitrogen to 3 parts potassium is favored.

Ammonium Versus Nitrate Nitrogen

Three forms of nitrogen are used for fertilization: nitrate (NO_3^-), ammonium or ammoniacal (NH_4^+), and Urea.. Plants vary in response to these forms. The response to ammonium and urea is generally identical in plants since urea must be converted to ammoniacal nitrogen to be assimilated in plants. Plants, such as azalea and rhododendron, that grow well in highly acid root media developed best on a high proportion of ammonium nitrogen. Other crops, however, may be injured when more than 50 percent of the total nitrogen is provide as ammonium plus urea. Best growth is obtained when a mixture of nitrate plus ammonium and /or urea is supplied. If fertilizers are selected having 40% or less of the total nitrogen in the ammonium plus urea form, no ammonium toxicity should be encountered with any crops in any season.

Since ammonium toxicity is a threat, growers may be tempted to drop ammonium out of the fertilizer altogether. This would be a mistake. Plants tend to be "hard" when grown on all nitrate nitrogen. That is, leaves stems and overall plant size is smaller. For plants in general, it is best to use a mixture of nitrate and ammonium which includes between 15 to 40% (50% maximum) of the nitrogen in the ammonium form, There are situations such a in plug seedling production when it is desirable to force the plants into a compact growth form. A 100% nitrate nitrogen fertilizer is used in these situations.

The standard greenhouse fertilizer used until this past decade was 20-20-20. This fertilizer contains approximately 70 percent of its nitrogen in the ammonium plus urea forms. Ammonium toxicity was not attributed to 20-20-20 fertilizer until soilless media become popular. Soilless media tend to be lower in pH level than soil-based substrates. The optimum pH for bacteria that convert ammonium-nitrogen to nitrate-nitrogen in the soil is slightly above 7.0. In the pH range of 6.0-7.0 used for soil-based media, adequate populations of bacteria develop to reduce the high level of ammonium plus urea supplied by 20-20-20 fertilizer. This is not true for soilless media, where pH values below 6.0 are established, and ammonium toxicity is a greater concern in soilless media.

Nitrogen Management for Cut Flower Production

Nitrogen applications are needed on an annual basis for production of most cut flowers species. The rate of application varies wit plant species. For cut flower production divide plant nitrogen needs into three categories***: "low," "medium" and "high" requirements.*** Plants that are harvested all summer through to the fall usually have higher nitrogen requirements than early season harvested cut flowers.

If using the higher rates of nitrogen on crops that flower over a long period of time, it may be beneficial to split the applications into two or more applications especially if using water-soluble forms of nitrogen such as ammonium nitrate or urea. If using controlled release nitrogen sources, a single application can be made early in the season but in any case nitrogen levels should be monitored with regular tissue tests.

Nitrogen Application Rate Recommendations

Nitrogen Range	Rate (Lb N per 1000 sq.ft.
Low	1—1.5
Medium	1.5-2.0
High	2.0-3.0

Table 2. Standard concentration requirements of fertilizers containing 20 percent nitrogen for several greenhouse crops.

		Concentration*			
		Weekly		Constant	
Crop	Concentration category	oz/100 gallons	g/l	oz/100 gallons	g/l
Daffodil	None	—	—	—	—
Iris	None	—	—	—	—
Hyacinth	None	—	—	—	—
Tulip**	Very light	—	—	—	—
Snapdragon	Very light	16	1.2	6	0.5
Bedding plants	Very light	16	1.2	6	0.5
Elatior begonias	Very light	17	1.3	8.5	0.6
Azalea	Light	20	1.5	—	—
Gloxinia	Light	20	1.8	10	0.8
Rose	Moderate	32	2.4	10	0.8
Carnation	Moderate	32	2.4	13.5	1.0
Geranium	Moderate	32	2.4	13.5	1.0
Easter lily	Moderate	32	2.4	13.5	1.0
Chrysanthemum	Heavy	40	3.0	15	1.1
Poinsettia	Very heavy	48	3.6	17	1.3

*13.5 oz of 20 percent nitrogen fertilizer/100 gallons = 200 ppm nitrogen.

**As an insurance against nitrogen and calcium deficiencies, calcium nitrate should be applied at the rate of 32 oz/100 gal lon (2.4 grams/liter) at the start and at the midpoint of the growth-room stages and at the start of greenhouse forcing.

Table 3. Nitrogen (N) : potassium (K_2O) ratios for various crops.

Crop	N : K_2O
General	1 : 1
Azalea	3 : 1
Begonia	2 : 1
Carnation	2 : 3