Water Quality Issues for Slipper Orchid Growers
AnTec Laboratory - Bob & Lynn Wellenstein

Everyone's conditions are very different, and you must balance the various factors of your growing with each other. What is stated here are the factors we take in to consideration regarding water quality: it is hoped that there may be aspects discussed that may be useful to you. We suggest that careful experimentation on small numbers of plants be carried out before anyone makes any major change in their growing conditions. Also, everyone does not have the same goals in growing, and may not be interested in trying to tease every last bit of potential out of their plants. As a result, we'll also discuss some options to consider if you want to grow these plants under less optimal water quality conditions without the extra expense and trouble of water purification.

The first step in determining water quality and how it will affect your Slipper Orchids is to get a water quality analysis. If you are on a municipal water supply your DPW should be able to provide one to you. Be sure to inquire if multiple sources of supply are used, eg. different wells or surface sources, as there can be tremendous differences between them that may cause large differences in your plants' health. If you are on a private well supply you will probably have to get an analysis done at your own expense. TDS (Total Dissolved Solids) is the sum of all the mineral contituents that are soluble in water. The presence of these minerals is determined by the geology of the watershed or course the water travels before reaching your tap and the solubility of rocks and soils the water comes in contact with. There are a wide variety of substancesor dissolved solids like sodium, chloride, sulfates, calcium, bicarbonate, nitrates, phosphates, iron, and magnesium that the water picks up. For example, water that flows through limestone and gypsum dissolves calcium, carbonate, and sulfate. One test for TDS is performed by evaporating off all of the water in the test sample. The remaining matter is then weighed and the results are expressed as parts per million (ppm) or milligrams per Litre (mg/L). You can get a general idea of the TDS by measuring the specific conductance in microsiemens (hand held instruments for this can be purchased in the $50 range) and multiplying by a factor of 0.55 to 1.0 to obtain the TDS in mg/L (ppm) (see explanation of the range below). Some notes on measurement are in order at this point.

- Electrical resistivity is the A/C resistance in ohms measured across a 1 cm distance of the water solution at a standard temperature. The unit of resistivity is the ohm/cm.
- Electrical conductance is the inverse of the resistivity, or 1/ohm= 1mho.
- 1 mho = 1 Siemen (S) = 1000 millisiemens(mS) = 1,000,000 microsiemens(uS)
- Grains, or grains per gallon (GPG) is an ancient measurement still in use roughly equal to 1 dry wheat grain (1/7000 lb). 1 grain per gallon = 17.1 ppm.
- 1EC (electrical conductivity or earth conductivity) = 1 mSiemen = 1000 uSiemens
- Electrical conductance meter readings cannot be exactly converted to ppm, although many are sold with scales reading in ppm. An approximation coversation factor has been added. Each dissolved salt in the solution has a different conductivity, a chart of representational values follows:

1 PPM of:	=	Approx. microsiemens/cm (20 C)
$MgSO_4$	=	0.80
$MgCl_2$	=	1.70
KNO_3	=	1.10
K_2SO_4	=	1.20
KH_2PO_4	=	0.60
K_2HPO_4	=	1.04
NaCl	=	1.64

$(NH_4)_2SO_4$	=	1.50
Urea	=	0.00

- pH is the measure of acidity or alkalinity of the solution, 7 being neutral, less than 7 acidic and greater than 7 basic. It is a log scale, so going from 8 to 9 is a ten fold increase ($pH = -\log[H^+]$)

Okay, we should have enough information there to let you be able to make conversions between any of the usual expressions of measurement of TDS in water, although if you are like me it'll make your head hurt.

The first step is to determine from your water analysis how your water stacks up for slipper culture. Don't depend on others opinions that XXX city water is great for orchids, so and so grew great Paphs, as everyone has different goals and idea of what constitutes good culture. If your water has a TDS level of 60 ppm or below and doesn't have excessive sodium (let's say its 5 ppm or less) or of the trace elements, you probably are one of those lucky folks that has perfect slipper growing water. I've seen water quality reports from North and South Carolina, Georgia, Colorado and the Downstate New York area with these wonderful values. You simply need to pick a fertilizer that matches your water, ie do you need any additional calcium or magnesium, or is your water adequate, and be careful what the pH of your water/fertilizer mix is, as your water may not be very highly buffered against shift. If the results are in the 60 to 120 ppm range, you'll have to make some decisions, perhaps based on experimenting with some of your plants and a purer water supply to see just how much improvement you may get in growth. At about 120 ppm range and up, or if you have sodium that's 10 ppm or higher, or excess microelements, if you are serious about growing your slipper to the maximum, you may want to consider a water purification scheme. A frequently asked question is regarding the possible use of bottled "spring water". The answer is, it depends on the analysis. Spring water is not necessarily low TDS water, in fact some are touted for their mineral content, so the same rules that apply to your tap water apply to the spring water, you need to ask for a typical analysis, or take a conductivity reading yourself on a sample.

If you have decided you are not satisfied with your tap water quality, your next decision is what to do about it. There are several options available which all give suitable results, the choice of which will revolve around water availability and relative cost in your area. Before we discuss these options, lets discuss some that are not suitable. Water softening is an ion exchange procedure that will make your water completely unsuitable for orchid growing. The procedure essentially replaces the calcium and magnesium ions in your water with sodium ions, and these makes the water ultimately toxic to your plants, and quite frankly not too healthy for you either. It is commonly suggested that you can use softened water if you substitute potassium salts for the sodium salts. This certainly is a much better solution, but again, if your water was high enough in TDS to start with to warrant softening, you are going to end up with very high potassium levels that can affect (antagonize) the availability of nitrogen, calcium, magnesium, iron, manganese, zinc and copper, so I do not feel this is a good option either. Your best bet is to get a tap installed in your plumbing ahead of the softener and take your irrigation water from this tap. You might also want to consider installing an under sink RO unit for your drinking water to reduce your sodium intake. Also, there are various cartridge filters available. Usually these are simply sediment, carbon, or special resin cartridges that are useful for increasing the taste and safety of the water for you, but do little in lowering the TDS you are concerned with for your plants. There are some small deionization units utilizing a mixed bed resin that will remove the TDS, but this type of disposable cartridge DI unit will be quite expensive to operate.

The easiest way to obtain pure water is to collect it in the form of rainwater or snowmelt. If you have the means to collect and store sufficient quantities that may be the least expensive option for you. A few cautions do apply, however. First, it's probably best not too collect the first several minutes of rain from any storm, let the worst of the atmospheric pollutants and debris on your collection surfaces wash away before you start collection. Also, be aware that rainwater in some parts of the country can be extremely acidic, normal rainwater had a pH of about 5.6 due to dissolved $CO_{2,}$ it will approach neutral upon sitting and outgassing for a few days, but we have measured the rainwater here in Upstate New York as low as 3.2, with a TDS of 22 even 30 minutes after the start of the rainfall. The final caution is to store the water in the dark, and consider adding a very small amount of a growth retardant such as Physan 20 to limit bacterial and algal growth.

The simplest method to purify water is distillation. The resultant water is quite high quality, but few people have access to the appropriate equipment. An average energy price to distill a gallon of water in the US is currently put at about $ .35, and it is available in the supermarkets and drug stores in our area for about $ .95 per gallon, so it is quite expensive an option, suitable probably only for someone with just a few plants or for experimentation to see if pure water will significantly help your plants.

The most mentioned method of water purification is by processing the water through a reverse osmosis filter. The principle is that as the water pass over the membrane water is able to pass through the filter while most of the dissolved solids can not. These are removed in a tangential flow pattern from the filter with the use of excess water, which is then discarded (in more efficient systems a percentage is recycled). Reverse osmosis can produce very high quality water in large quantities with relatively little energy input. The drawback is the "waste" water that is discarded, which can vary from 1 to 3 gallons for each gallon of pure water produced (higher efficiency units are available, but generally are out of the size range likely to be used in orchid culture), so if water is in short supply or very expensive, then this may not be the best option. We have used RO for many years now and are very pleased with the quality of the water. A note on purchasing RO units is also in order, they are not all made equal. RO unit output is dependent on water pressure and water temperature. It is also dependent on manufacturer, and quite frankly I've encountered at least one that badly over rates their systems, so beware, and if your system does not perform any where near the specifications, contact the supplier. Because your water pressure may not be as high as that at which units are rated, and also will almost certainly be colder, and because slipper growers tend to increase their collections steadily, I suggest you consider buying a unit rated several times over what you think you need. Also, you may be advised that your unit membrane will last much longer if you soften the water before processing. If you decide to go this route, consider using the potassium salts mentioned earlier in this article. RO units do allow some passage of the minerals across the membranes, my units let 6 to 10 ppm through, and if you are softening the water with sodium salts this will be 6 – 10 ppm of sodium you are letting through. The importance of softening to preserve membrane life increases with the efficiency of the unit, ours at 2.7 gallons of reject per gallon purified have given us about five years life running continuously and converting 250 ppm unsoftened water to the 6 – 10 ppm water we use.

Deionization is performed usually by a two tank apparatus, the first tank being the cation resin exchange tank where positively charged ions are exchanged with H^+ ions. This process produces acids which are removed along with other negatively charged ions by the anion resin exchange tank. The tanks need to be recharged periodically. Most systems are rented from a water purification company, and they will either regenerate the tanks on your premises periodically or preferably exchange the tanks with fresh ones for you (the recharge process involves the use of strong acids and bases). Cost varies according to region, but you usually pay a monthly rental fee for the unit and a per tank recharge or replacement fee. The water quality is excellent, the systems can produce large quantities of water on demand and with no wasted water they are an excellent choice where water conservation is of ultimate importance.

What can you do if you or someone you are advising has less than good quality water, but isn't in the position to take one of the described steps to improve the quality, and does not have access to rain water? There are several possibilities, one is to limit oneself to species and hybrids that are known to be less sensitive to higher salinity. Also, bear in mind that there are clonal variations in sensitivities, so exchanging divisions that grow successfully for others with the same problems is a good idea. You should also use fertilizer sparingly, and utilize ones with highly available nitrogen sources and little or no urea, so that the smaller amounts of fertilizer you can use will be utilized efficiently. You should also flush the pots extensively with you irrigation mix with every watering. Not allowing the media to dry completely will aid in salt elimination, but can also lead to rotted roots, so using a more open mix than you normally would and watering more frequently may also be of help, letting you water without the mix completely drying out but still keeping some air supply at the roots.

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