SEMI-HYDROPONICS

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LIFE EVENTS OFTEN DICTATE CHANGES in how we grow our orchids. Our son was born on a mild winter night in 2006 and our lives were changed for the better. Everything within our control was in order for his arrival—except for one thing. One of our growing areas was in the room next to his nursery. It became a problem when restricted access eventually led to the slow decline of the plants. When he napped, it was difficult to tread lightly enough in the neighboring room to avoid waking him. It is amazing just how noisy tending orchids can be. Blowing fans and the buzzing of lighting ballasts do, however, provide a lovely white noise our son still seems to enjoy. With our time taken by child care and working, we were able to give only minimal care to those orchids, mostly *Phalaenopsis* and compact and miniature *Cattleya* alliance hybrids. They slowly declined–no number of quick mists can equate to a deep watering. After a couple months of mistreatment, we noticed desiccated, floppy leaves and pseudobulbs, and insects and mites invading the weakened plants. Something had to be done quickly. Luckily, our beloved slipper orchids were safe in a growing area well-removed from the nursery.

We belong to several orchid societies, but we also like to travel extensively across North America giving talks (brainwashing) folks about growing orchids under lights and about the pleasures of growing paphiopedilums. While attending society meetings and traveling we have witnessed the results of semi-hydroponics innumerable times. We were very satisfied with our results using fir bark mixes and New Zealand sphagnum moss prior to the birth of our son. However, with more and more chatter about "semi-hydro" at society meetings and online orchid forums, we decided to experiment with semi-hydroponics. After all, the orchids needed a change and even something drastic couldn't be any more harmful than their already worsening situation.

What is Semi-hydro?

Semi-hydroponics is a self-contained version of modern hydroponics. In traditional hydroponics, the crop is usually a single species or cultivar. Use your imagination. The plants share a common growing basin and water with nutrients is continuously or intermittently pumped through the inert growing media over the plants' roots. Timer-controlled pumps regulate the water flow, and water is recycled until fouled and/or depleted of nutrients. The media is inert and contributes little to no nutrition to the plants. Semi-hydroponics considers that orchid growers aren't growing a room full of…um, tomatoes. Since the "crop" is orchids with various needs, it is necessary to segregate them into individual containers. Providing plumbing and controls to monitor water flow becomes cumbersome as the number of containers increases. Semi-hydroponics eliminates the automated recycling aspect; the grower becomes the recycling pump. The container and media provide the plant with the proper combination of moisture, nutrients, and air.

Semi-hydroponic containers have no bottom drainage, only a couple of small holes on the side about an inch (2.54 cm) from the bottom creating a pool, or reservoir. The media used must allow "wicking," the ability to move moisture and dissolved nutrients up to the root system from the bottom reservoir and allow air movement but not break down. The concept of growing orchids sitting in water is not a new concept. Phragmipediums are commonly grown sitting in shallow trays of water. However, the use of inert, non-decomposing media results in less root rot due to mix decomposition. Using individual containers reduces the spread of pests and pathogens as well as allowing one to customize conditions for individual plants in a mixed collection.

Even orchids that appreciate occasional drying, such as *Cattleya* Love Knot (*C. sincorana* x *C. walkeriana*), adapt well to semi-hydroponics likely due to the aeration available at the root zone.

Media

Inert media that does not decompose is the key that sets hydroponics and semi-hydroponics apart from traditional "dirt gardening." Once we made the decision to take the semi-hydro plunge, our first major consideration was media choice. We wanted something we could get locally in quantity, at an affordable price, and at a moment's notice. Semi-hydroponic media should be inert, non-decomposing, crush-resistant, and of moderate pH. The media should have little to no encrusting or entrapped salts that could contribute to salinity, hardness, or total dissolved solids (TDS).

Several semi-hydro media types are available: the lightweight expanded aggregates (LEAs), lightweight expanded clay aggregates (LECAs), and lightweight expanded shale or slate aggregates (LESAs). LECAs are marketed specifically for horticulture and can be expensive in the large quantities needed if we decided to switch all or a decent portion of our collection over to semi-hydro. LECAs are regarded as the superior class of LEAs for semi-hydroponics. In general, proprietary hydroponics and semi-hydroponics media are made from clay. Shale and slate LEAs (LESAs) are less porous and uniform in grading, but perform adequately if some attention is given to their faults.

Sponge rock, a large grade of perlite or volcanic glass, is not a long term semi-hydroponics media solution because it floats and crushes easily. A layer of pea gravel can be added on top to hold sponge rock down, but as sponge rock crumbles over time, air space is greatly reduced. It is a temporary medium at best.

We knew an incredible orchidist that grew in straight pea gravel, but pea gravel has very poor wicking capabilities, no internal pores, and is heavy. It can be useful in very humid conditions or when top watering or misting is frequent. Pea gravel is usually very inexpensive and comes in many color choices.

Coarse sand can also be used as a semi-hydroponics media. However, it is heavy and can pack very tightly. Coarse sand would wick water slightly better than pea gravel since particles pack more tightly, but close packing can prohibit air movement within the container. We use coarse sand in our bark mixes quite successfully and might give it a shot for semi-hydro someday just to say we've tried it.

Silicon-rich media are also sometimes used in semi-hydroponics. These media are typically composed of fossilized freshwater diatom exoskeletons. Silicon strengthens cell walls which gives the plant pest, temperature, and drought resistance. It does have some degree of porosity which aids wicking and air availability at the root zone. Siliceous media are also lighter than pea gravel and sand. Its drawback is its tendency to pack and the cost; the cost is the same as the LECAs, but it is less efficient at wicking. Some siliceous media may also raise the pH of the root zone dramatically. Some growers mix siliceous media and LECA in various proportions to gain the advantages of silicon. However, silicon can be provided via soluble formulations and applied as a root drench or foliar feed, reducing the attractiveness of silicon-rich media compared to LECA.

While shopping for mulch one spring, we ran across red lava pebbles, or red cinder, at our local hardware store. The pebbles ranged in diameter from about three sixteenths to three quarters of an inch, similar to many grades of bark; it was not the large, more common landscaping lava rocks. The price was perfect at one-fifth to one-tenth of the price of engineered lightweight expanded clay aggregates, and they had pallets of the stuff minutes from our doorstep. We bought a couple bags even though we were aware of extensive research that proved manmade LEAs are better performers in semi-hydroponics. For the tradeoff in price, availability, and convenience, we were very willing to give lava pebbles a fair try under our conditions. For smaller hobby collections, we would recommend using "proper" semi-hydroponic media for best results.

Some examples of media used in semi-hydroponics.
Front row, (all left to right): medium grade Growstone, Hydroton, lightweight expanded shale aggregate (LESA).
Middle row: coarse Growstone, sponge rock, red lava pebbles.
Back row: coarse sand, pea gravel.

The lava pebbles are prepared like other semi-hydro media. They are placed in a bucket filled with reverse osmosis water. The lava pebbles have little total dissolved solids after two rinses, but a significant amount of suspended red silt and red mud results so we now rinse it in a colander before soaking. For the second soak, we add a vitamin and rooting hormone solution per the manufacturer's instructions. Allow your media to soak at least overnight for each step, particularly the final vitamin/hormone soak.

We have also used lightweight expanded shale aggregate (LESA) marketed as a landscaping soil amendment and growing medium for rooftop gardens. It has performed well, but requires rinsing, soaking, and possibly grading to achieve a more uniform component diameter. (We received a mix of different sizes from dust up to about 5/8 of an inch with a large proportion being below 1/4 inch.) Some variability is acceptable and even desirable, but with such a varied mixture, the air-holding capacity may be reduced as the medium packs, filling interstitial spaces. Tight packing may also inhibit roots from penetrating the media properly. Just as with bark mixes, it is useful to mate the proper diameter mix with the roots of the plant. A balance must be achieved. For "non-traditional," un-optimized, non-engineered semi-hydro media like lava pebbles and landscaping LESA, tighter packing and smaller diameter helps to improve wicking, but can choke out air and root spaces.

We have since relocated and have yet to identify a local source of red lava pebbles, so we are using Hydroton® from the local hydroponics store. We immediately noticed a difference in pot weight and plant stability. All else being equal, a pot full of wet LECA is lightest, pea gravel is heaviest, and red lava pebbles and LESAs are intermediate in weight. Immediately after repotting, plants may be slightly wobbly in Hydroton®. Since it is fairly consistent in diameter and nearly perfectly spherical in shape, it does not pack as well as the irregularly shaped and sized red lava pebbles. As plants establish and media settles, stability improves. A significant percentage of the Hydroton® will also float which can minimally be irritating when watering. Over time, floating is lessened as roots bind the media. We have seen but not tried PrimeAgra®. It is similar to Hydroton® in appearance but is less consistent in size and shape. These attributes would improve stability issues experienced with Hydroton®. It would give improved wicking from the gently interlocking components without excessive small particles to clog interstitial spaces. PrimeAgra® is likely the most ideal semi-hydro media available. Your media choice will depend on availability, amount required, performance, and possibly shipping weight.

We are starting some trials using expanded recycled glass as semi-hydro media marketed under the name Growstone®. It is much lighter than red lava pebbles due to a greater porosity which should also increase its wicking capabilities. A very small proportion of it floats, and it has decent grading with irregular shape that enables good plant anchorage. The cost is roughly the same or slightly less than LECA.

All of these media can work–use what is reasonably available and has the traits required for your growing conditions. In fact, there are many other media that we have not discussed. Shoot, we've even heard of using loose Lego® building blocks as semi-hydro media. If it works, it works. If not, try something else.

Lightweight expanded shale aggregate, LESA, can have an attractive mix of colors.

Notice the consistent, fairly spherical shape, size, and color of the Hydroton®.

All photos ©Ernie Gemeinhart

When working with dry, dusty media, wear a dust mask and work in an area of excellent ventilation. Breathing dust and fine particles can have serious long-term health implications.

Red lava pebbles and pea gravel are inexpensive enough to be replaced; the material can be used in your landscape when you are finished with it as potting material. Engineered LEAs can also be used in the landscape but will end up being high dollar mulch!

Semi-hydroponics media can be reused if properly sterilized; however, never reuse media from a diseased plant, especially if you suspect or confirm it was virused! To reuse, place the media into a bucket with just enough water to allow you to stir the media. Swirl it around vigorously to dislodge any remnant roots. Decant off or strain the remaining water and repeat until the runoff is free of debris. Once clean of roots, you may choose to bleach, bake, autoclave, or microwave your media to sterilize it. Sterilizing will prevent the spread of disease and pests, but not always viruses. We use a solution of one part household bleach to nine parts water. Soak the media overnight followed by a thorough rinse. Repeat this with several overnight soaks in fresh water. Once the media is clean and sterile, soak it overnight in a hormone/vitamin solution.

Autoclaving, pressure cooking, microwaving, and baking will also sterilize media, but could generate an odor if the media is not completely cleaned of organic material. Yes, bleach stinks too, but at least you can keep it in the garage or outside. We do not use these methods because of the potential for odor and because a larger amount of media can be sterilized in a given amount of time with the bleaching method.

To use a combination of steam and pressure to sterilize, follow the instructions on your pressure cooker or autoclave to achieve 250°F (121.1°C) and 12-15 psi (0.83-1.03 bar) of pressure for at least twenty minutes.

To sterilize in the microwave, place pre-cleaned media in a heavy weight microwaveable container or strong plastic bag—do not seal the container or bag. Microwave long enough to achieve a minimum temperature of 200°F (93.3°C). Times will vary drastically with the amount and type of media and the size and wattage of your microwave. Some media may have traces of metals, so test a small batch first. Discontinue microwave sterilization if you see sparks or hear crackling.

To sterilize in the oven, preheat to 200°F (93.3°C). Spread your pre-cleaned media out, preferably as a single layer, on aluminum foil-covered baking sheets. Bake the media at 180-200°F (82.2-93.3°C) for thirty minutes. There is some debate over the temperature required to achieve pathogen-free media. Use this method at your own risk.

Containers

For "pots," the choice is a little more transparent; or at least translucent, to be more accurate. We wanted containers in which we could easily monitor root growth and media moisture. The best are deep and translucent to transparent. You can use anything from empty pop bottles, milk jugs, plastic drinking cups, deli containers, yogurt cups, to margarine containers.

The common recommendation is deli containers, and there was no reason to reinvent the wheel. We started with a handful of one quart (0.95 l) deli containers obtained gratis from the grocery store deli counter and a mixture of containers we had in the kitchen. The depth allows for the roots plus an inch or so of a water reservoir. Let's define "deep" as the container height is roughly equal to or greater than the width (diameter). We use round, one quart (0.95 l) containers that are 4.5" (11.43 cm) in diameter and 5.5" (13.97 cm) tall; one gallon (3.8 l) containers that are 7.4" (18.80 cm) in diameter and 7.5" (19.05 cm) tall; 20 ounce (591.47 ml) drinking cups that are 3" (7.62 cm) in diameter and 4.5" (11.43 cm) tall. To determine the size of your container to your plant, consider the traditional pot size you'd use then add an inch (2.54 cm) to its height to allow for the water reservoir. Match the root ball to the container, but it is safe to use a slightly larger pot than for traditional bark culture since the media will not decay and allows for efficient, copious air exchange.

Piece of cake, right? Nope… pound of potato salad (save the container)!

Some examples of semi-hydroponics containers.

Potting into Semi-hydro Media

Now that we had containers and media, it was time to repot some plants. We decided to start with the phalaenopsis. They quickly generate new roots and make startling recoveries just in case this un-scientific experiment failed. We prepared the phals by drenching them, while still potted, two days in a row. We believe thoroughly hydrating the roots made them more malleable which prevented breakage. Such an extended process of hydration is not always necessary; remember, we started this experiment as a rescue project for stressed, poorly hydrated plants. (For healthy plants, we repot after one deep watering.) The third day, we removed them from the pots, rinsed to remove media and possible bugs, and carefully teased away attached organic media that could possibly foul their new homes. Once out of the pot, old, dead roots were cut off with a sterile blade.

An inch (2.54 cm) of drained, prepared media was added to the new container. The monopodial phalaenopsis were centered in the containers and the media filled in around the roots by pouring and tapping it into place. (Sympodial orchids are potted with the oldest pseudobulbs against the container wall and newer growths towards the center or opposite end of the container.) Once media reached the base of the plant, the container was filled with reverse osmosis water with quarter strength fertilizer (typically Michigan State University pure water formula or one of several DynaGro® formulas) and rooting hormone/vitamin solution. The plants were allowed to soak in the solution for one to four hours (randomly as time dictated), and then the pots were tilted to drain off as much excess water as possible.

Phalaenopsis I-Hsin Spot Eagle 'Montclair' AM/AOS, note the emerging and existing roots reaching for the LESA.

Roots of a Maudiae-type *Paphiopedilum* hybrid recruiting into red lava pebbles.

All photos ©Ernie Gemeinhart

At this point, holes were carefully added about an inch (2.54 cm) from the bottom of the container and the remaining water was allowed to drain out. We typically add two 1/8” to 1/4” (0.32-0.64 cm) holes spaced about an inch (2.54 cm) or less apart. If the holes are too large or too numerous, it is difficult to fill the container to the top because it will drain out faster than you can add it. Initially, we simply poked holes with a pair of heavy, sharp scissors which worked well on drinking cups and thin-walled quart deli containers. However, the heavier-walled containers cracked, so we now heat a wire coat hanger with a torch or a gas stovetop burner and burn the plastic to create holes. Take care to provide very adequate ventilation when burning plastic! We also toyed with “pre-drilling” the holes, but discovered we were careless about plant positioning and the holes usually ended up on the “wrong” side of the pot.

The “wrong” side of the pot? At that time, we grew our plants indoors under lights. A certain degree of care was necessary to ensure that the containers didn’t drain onto the floor when we watered. How each plant was positioned on the benches was considered because the holes would have to face inward toward the bench drainage trays. We also got into the habit of placing plant name tags on the opposite side as the holes and with writing facing outward. That was a visual cue to the location of the drainage holes and helped us reposition plants we moved around–if we could read the label, the container would likely drain inwards toward the drainage tray. Make your labeling system and hole location work for you, keeping in mind that consistency will prevent the occasional wet shoe.

Once plants were potted, we placed them on the bench, crossed our fingers, and waited. For about a month after repotting, we continued to use rooting hormone and vitamins in our feed water to encourage new root growth and ease stress from the drastic transition.

It is advantageous to repot plants into semi-hydro when new roots are just initiating. Not a unique recommendation as this also helps plants establish quickly in organic mixes. Old roots adapted to organic mixes commonly die back to some extent as new roots fill the containers. Care should be taken not to place the exisitng roots below the level of the container drainage holes because they will invariably rot if they are constantly submerged in the reservoir. Yes, new roots can quickly inhabit the reservoir, but they like to grow there on their own volition and not be forced.

The reservoir at the bottom of the container provides a constant supply of water to the plant above. As the water moves upward through the pot, much will be used by the plant. Whatever gets past the roots will evaporate and thus cool the container and roots via evaporative cooling. This phenomenon may possibly increase local humidity near the plant. If the roots remain too cool, rot problems may occur. If you can't provide warmth, consider repotting in the spring or early or late summer. If you can provide warmth, repotting can be done at any time roots are emerging or actively growing. Keeping the plants above 65°F (18.3°C) until established is helpful. If the growing environment cannot be kept that warm, consider bottom heating. We found that placing plants on top of an aquarium over the fluorescent light strip is useful when you have a couple plants. Good sources of bottom heat are warm radiators or the top of the refrigerator. Heat mats or coils could be used for a large number of plants.

Watering and Fertilizing

Watering is simple. When the reservoir is almost dry (not completely dry), fill the container all the way to the top and allow it to drain naturally down to the level of the holes. Done. We've given some plants to friends and family with those simple instructions, and they all managed to keep the plants healthy and even bloomed them. We got comments like "it sure is easy to care for them." Obvious exceptions to this instruction are for plants that require a seasonal dry rest (*Cychnoches*, *Lycaste*, some dendrobiums, etc). Always flush the pot very well with plain water before allowing plants to go bone dry; this prevents mineral buildup on the media and drastically reduces the chances of root tip burn.

To fertilize, simply add the desired amount of soluble fertilizer to the irrigation water. The standard orchid fertilizing mantra applies equally well to semi-hydro growing: weakly weekly. If you want to get scientific, we'd recommend a range of 50 to 250 parts per million of nitrogen. Use more when growth is strongest, such as when temperatures and light intensity are optimal, or if your plants are heavier feeders. Use the lower end of the range in cooler, dimmer weather or for lighter feeding plants. Being conservative with fertilizer is also recommended if your irrigation water is "hard" or has more than, say, 100 parts per million (ppm) of total dissolved solids (TDS). More on irrigation water follows.

Inert semi-hydroponic media will not contribute any nutrition to your plants as organic media can. It is crucial to chose fertilizers with macro- and micronutrients. We are very satisfied with Michigan State University and DynaGro® formulas. We own many different fertilizers and like to rotate them to give our plants a complete diet. Michigan State University (MSU) pure water formula (13-3-15 +8 Ca, 2 Mg) is the fertilizer we use most, and is applied regardless of the season or growth phase. For those using tap water or water containing calcium and magnesium, the 19-4-23 MSU formula is perfectly acceptable. Many fertilizers are available. Any complete fertilizer can be used. Orchids aren't terribly picky as long as they aren't overdosed. If you choose to vary the formula by season, phase of growth, flowering, etc, the choice is yours; be sure your plants are getting complete nutrition. In our opinion, the amount of fertilizer used and presence of micronutrients is much more important than the exact proportions of each ingredient.

We are currently tinkering with time-release fertilizers in semi-hydroponics. We are experimenting by placing it either at the bottom of the container in the reservoir, in the middle of the pot, or sprinkled on top of the medium. Time-release fertilizers do not always supply micronutrients, so a soluble complete fertilizer will be needed as an occasional supplement at lower dilution rate. The jury is still out, but we haven't seen any negative effects yet—just don't overdo it.

Foliar feeding should not be overlooked. There are many contradictory results reported, but nutrients without chelating agents such as EDTA (iron and copper are commonly chelated) should be able to be taken in through orchid leaf stomata. Weak solutions are desirable for foliar feeding; wet both upper and lower surfaces of the leaves.

The roots of this spiking *Phalaenopsis* Venus (*Phal. lindenii* x *Phal. equestris*) keiki grew into the reservoir within weeks of being potted up into red lava pebbles.

Water

In our opinion, it is a misconception that one must use pure water for semi-hydro. Examples of "pure" water are reverse osmosis water (RO), deionized water (DI), distilled water, rain, and snow melt. You can make semi-hydro work for you if you have tap water with high total dissolved solids (TDS) as indicated in daily life observations (white buildup on dishes or in the shower) or by measurement with the aid of a TDS meter. After you water or fertilize, use a small amount of pure water in a pump or trigger sprayer to rinse the upper layers of the media. This will wash the fertilizer further down into the pot to be taken up by the roots. Water more frequently to keep the media moist which keeps the dissolved salts in the water from concentrating and drying on the roots and media; this reduces the chance of root burn. Unlike organic media, which decomposes rapidly, the semi-hydro media is inert and will not decom-

Twenty ounce disposable drinking cups are great for plants you'd typically pot into a 2.25-2.5 inch deep pot.

pose. Consider flushing the pots with plain water more frequently. If your water source is high in total dissolved solids, you should consider using fertilizer at lower rates and be cautious with plants that are sensitive to excessive dissolved solids in their water. With this treatment, you should be able to maintain crust-free media, healthy roots, and happy orchids.

The pH of the irrigation water is important. Each fertilizer formula will alter the pH of the irrigation water. If water is too acidic or basic, certain nutrients in the fertilizer may become unavailable to the plants. We try to achieve slightly acidic irrigation water or fertilizer solution (around 6.5 pH for the container efflux), but satisfactory results can likely be obtained with a pH between 5.5 and 8.0. The root microclimate can have an effect on pH. We recommend testing the pH of the water coming from the drainage holes to get an accurate measurement of the pH at the root zone.

Watch your plants for signs of nutrient deficiency. As a rule, growths should be as large as or larger than older growths and should not have chlorotic (yellow) streaks or tips. Older growths can also maintain their color and size in healthy plants. Premature leaf drop or chlorosis (yellowing) in older leaves may indicate deficiencies in translocatable nutrients. Diagnose nutrient deficiencies carefully. The same symptoms are commonly indicative of fungus or bacterial issues, light intensity, or insect damage. You can use a variety of fertilizer formulas to avoid nutrient deficiencies.

TDS and pH meters are obtainable for about the price of a nice orchid in bloom. Allow space on your supply shelf and room in your budget for these valuable tools. If all is well, you might not need to test TDS or pH regularly, but if there are problems, these devices are useful in diagnosing the cause and prescribing a course of corrective action.

Advantages and Disadvantages

Weight: Even “lightweight” expanded aggregates are heavier than most traditional orchid mixes. This is advantageous if you have problems with top-heavy plants. The added weight is a drawback when it comes time to take plants to a show or orchid society meeting though. Invest in some heavyweight trays to transport plants in semi-hydro. Shallow dish pans work well too. The added weight makes shipping plants in semi-hydro unreasonable and media spilled in transit can damage leaves. Bare rooting is necessary for practical shipping.

Height: Taller semi-hydroponic containers tend to fall over more easily than traditional orchid pots, and tumbling semi-hydro media is potentially more damaging to plants than bark or coconut husk chunks due to its weight and hard, sometimes rough surfaces. Additional care is required to avoid knocking over plants on benches or during transport. Cats will need to be closely watched. They relish stealing media from pots and batting at arching inflorescences and can easily knock over containers in the process, spilling the plant, media, and water reservoir contents.

Leaking: When transporting plants in semi-hydro to the orchid society show, monthly meeting show table, etc. you don’t want water and nutrients from the reservoir leaking onto the seat of your car or moistening the display area. The proper transport trays mentioned above is one step. Consider partially draining the reservoir then placing heavy tape over the holes or nesting the container into another of the same size but without holes. You might find that your flowering plants in semi-hydro hold their flowers longer in fresher condition than those in traditional media in a dry, bright show venue over a long weekend. Don’t forget to restore proper drainage once returned to the growing area!

Evaporative Cooling: As mentioned, semi-hydro slightly cools the root zone as water evaporates from the container. This can be used to your advantage if you'd like to grow plants that prefer temperatures a little cooler than you can typically provide. The flipside is that if you grow warmth-loving plants in cooler than optimal temperatures, evaporative cooling provided by semi-hydro could be detrimental. Keep the plants warmer after repotting to counteract the negative effects of evaporative cooling; this helps with root growth. As plants become established in semi-hydro, they typically become less finicky with regards to temperature extremes and the evaporative cooling effect.

Humidity: As water evaporates from the container, local humidity near the plant can slightly increase, more so than in organic mixes that dry rapidly. Increased local humidity is rarely a bad thing, especially for folks growing in their home.

Repotting: In orchid culture, two basic events determine when to repot: plant growth and mix decomposition. In semi-hydro, repot when the plant outgrows the container or the media air spaces become clogged with algae or moss. Over time, algae or moss may begin to grow and clog the valuable pores and interstitial spaces blocking air movement in the container–small to moderate amounts of algae and moss can be beneficial as long as they do not limit air movement. Monitor the drainage properties of your containers, and watch for excessive algae and moss growth. Physan 20 or a 5-10% bleach solution will clear up such overgrowths, but dead algae can clog pores and spaces better than live algae. If algae and moss become an ongoing issue, consider using opaque containers, but be sure to monitor reservoir water levels. Alternatively, partially cover the upper outside portion of the containers so the reservoir can be seen. Electrical or duct tape wrapped around the upper half to two-thirds of the container works well as does a coat or two of opaque latex paint. Container color or "wrap" (tape, paint, etc) color can be chosen to tweak the root zone temperature. Black or red will tend to grab heat from the environment by absorbing light and will warm the pot and roots within. White will reflect light and limit container heating.

Root/media wetting: One of the biggest advantages of semi-hydro is that the media and roots are totally drenched when watering. Translucent/clear containers and a visible reservoir seem to encourage one to water properly. Be sure to fill containers to the top when watering. Semi-hydro culture in translucent pots allows one to monitor complete root zone hydration.

Pest and diseases: Semi-hydro can simplify pest and disease control. It is easy to apply pot drenches simply by temporarily sealing the container drain holes. Slugs and snails probably would prefer not to crawl over sharper media like red lava pebbles, sponge rock, and expanded glass, but don't expect these media types to eliminate such crafty, hungry pests. We've seen fewer pest and disease issues due to the increased vigor and health of the plants we've potted into semi-hydro.

What Does Well in Semi-hydro?

A simple rule of thumb is that anything will grow any way you want it to… as long as you throw enough time, effort, and money at it! The trick is to understand what works for you with an acceptable investment of time, money, and effort. Everyone's conditions are different and hobbyists tend to have several different growing areas or at least microclimates (if you don't at the moment, you soon will as your collection expands!). The best recommendation is to experiment with the plants you grow. Try a couple of this and a couple of that. All plants to be introduced to the semi-hydroponic method will certainly adapt more rapidly if new roots are initiating and if temperature, light, humidity, and nutrition are conducive to strong growth.

We recommend considering starting out with *Phalaenopsis* hybrids, phragmipediums, oncidiums, bulbophyllums, zygopetalums and their warmer-growing South American relatives, and hybrids from the *Cattleya* alliance. We were surprised how well orchids with pseudobulbs responded to semi-hydro. We could always keep *Cattleya* hybrids happy, growing, and blooming in bark mix, but with the limited humidity in the house under lights, the backbulbs would almost invariably shrivel once new pseudobulbs matured. Intuition says the nearly constant moisture will rot the roots of these more succulent plants that appreciate a brief drying between watering. For us, the tremendous amount of air at the roots encourages strong root growth and constant pseudobulb hydration. Just as in traditional mixes, the size of the medium can be adjusted to allow more air for plants preferring drier conditions. Varying the depth of the reservoir also works to satisfy plants that like wetter (deeper reservoir) or drier (shallower reservoir) conditions.

Paphiopedilums can be finicky when subjected to drastic changes, but vigorous plants will adapt nicely. Within the paphs, the members of the sections Coryopedilum (*Paphiopedilum rothschildianum* etc.), Pardalopetalum (*Paphiopedilum lowii* etc.), Cochlopetalum (*Paphiopedilum primulinum* etc.), Barbata (mottled leaf, warm growers that generate the "maudiae-type" hybrids), and Brachypetalum (*Paphiopedilum bellatulum* etc.) have responded quickly and favorably. Paphs in section Paphiopedilum (*Paphiopedilum villosum, P. charlesworthii,* etc.) that create the "complex" hybrids tend to be content in semi-hydro if the environment is warmer than their preferred intermediate to sometimes cool temperatures. Tread carefully with the Parvisepalums. The stoloniferous members of this section (*P. armeniacum* and *P. micranthum*) could suffer if new growths are sent down into the medium. Calcium can be supplemented to plants in semi-hydro just as you would supplement those in traditional mixes: as soluble fertilizers/supplements, top dressing for the medium, or through medium incorporation.

Fertilizer Conversion

Nitrogen parts per million conversion to approximate teaspoons per gallon of some common fertilizer formulas. The first value in fertilizer ratios represents the proportion of nitrogen (N); the second, phosphorous (P); the third, potassium (K). Hence the term "N-P-K". Note that the amount of fertilizer is based on the nitrogen proportion such that the same amount of 10-50-10 or 10-30-10 would be used for any given desired parts per million of nitrogen (ppm N).

Formula	Name	50 ppm N	100 ppm N	150 ppm N	200 ppm N	250 ppm N
13-3-15	MSU RO	0.25 tsp/gal	0.5 tsp/gal	0.75 tsp/gal	1.0 tsp/gal	1.5 tsp/gal
19-4-23	MSU tap	0.2 tsp/gal	0.4 tsp/gal	0.6 tsp/gal	0.8 tsp/gal	1.0 tsp/gal
30-10-10	Hi N	0.13 tsp/gal	0.25 tsp/gal	0.4 tsp/gal	0.5 tsp/gal	0.6 tsp/gal
10-50-10	Super P	0.38 tsp/gal	0.75 tsp/gal	1.0 tsp/gal	1.5 tsp/gal	2.0 tsp/gal
10-30-10	Bloom	0.38 tsp/gal	0.75 tsp/gal	1.0 tsp/gal	1.5 tsp/gal	2.0 tsp/gal

Comparison of Semi-hydroponics Media

Red lava pebbles are roughly one half inch in diameter, not larger lava rocks that can be several inches across. Lightweight expanded clay aggregates (LECAs) are specifically engineered to provide optimal conditions as semi-hydro media. Lightweight expanded shale and slate aggregates (LESAs) are made in mass quantities for rooftop gardens, soil aeration, and as lightweight cement additives; they are less consistent in size and shape than LECAs, but are slightly heavier, somewhat less expensive, and not as efficient at wicking.

Cost: more "$" means more expensive per cubic foot. The fewer $ the better. Price will vary with local availability and/or shipping weight.

Wicking: the ability of the media to carry water and dissolved nutrients from the reservoir up to the plants via interstitial spaces and pores in and on the media surface. More "+" means better wicking and excellent wicking is desirable.

Packing: tied to wicking since media that packs better will create smaller interstitial spaces thus enabling better wicking. However, excessive packing can decrease root and air space and can foul faster with algae. Good packing will give good plant stability immediately after repotting. More "+" means tighter packing.

Weight: more "+" means heavier media. Usually, heavy is bad, but not always.

Floats: buoyancy can be irritating as media can be washed out of the pot when watering. Shifting and floating media can also lengthen the time it takes for plants to establish firmly.

Crushes: crushing is not desirable as it will reduce the amount of air and root space in a container. All of these media except pea gravel will crush if you run over them with a truck, but sponge rock will crush if gently squeezed between two fingers.

Media	Type	Cost	Wicking	Packing	Weight	Floats	Crushes
Red lava pebbles	Natural	$	++	++	++	No	No
Sponge rock	Natural	$$	++	+++	+	Yes	Yes
Pea gravel	Natural	$	+	+++	+++	No	No
Sand	Natural	$	+	+++	+++	No	No
Hydroton® HyperGrow	LECA	$$$	+++	+	+	Yes	No
PrimeAgra® Hydroton® ViaStone HyperGrow LECA	LECA	$$$	+++	++	+	No	No
Stalite©, Haydite	LESA	$$	++	+++	++	No	No
Dyna-Rok® II Higromite™ diatomite SilicaStone	Siliceous	$$$	++	+++	+	No	No

We are having tremendous success growing deflasked community pots semi-hydroponically. The constant availability of water, nutrients, and air at the roots as well as the potential for increased local humidity is beneficial.

Do you like to grow specimen plants? It can be a challenge to grow a plant in the same container with organic media to specimen size. Using inert media and the semi-hydroponic method can be useful in growing plants worthy of prestigious cultural recognition. However, semi-hydro containers can be distracting to downright ugly. Consider your container for that prized specimen carefully or have a selection of attractive slip pots on hand to hide the container.

One group that should certainly not be grown semi-hydroponically is stanhopeas. They may grow well, but since the inflorescences are sent downward, beneath the plant, they will invariably rot. Gongoras, on the other hand, do quite well in semi-hydro, and they send their inflorescences in an arch over the lip of their container.

Many other plants do well in semi-hydro. We grow many different elephant ears (*Alocasia, Xanthosoma*, and *Colocasia*), *Dracaena*, *Heder*a ivy, *Aloe*, etc. very successfully in semi-hydro. Containers can be put into the ground in the warmer months as long as the surrounding earth drains well enough to allow water to drain down to the reservoir level. Bring them back inside when the weather turns cold.

Problems

Through discussions with growers that tried and did not have success with semi-hydro, we believe the most common mistake is failure to fill containers to the top when watering and feeding. Don't content yourself in simply maintaining the reservoir to the level of the drainage holes.

Another source of error is timing repotting. Repot when new roots are initiating and when you can provide the proper temperatures for establishment. Remember that plants typically become more relaxed in their temperature preferences once well established.

The strong interconnection between each and every aspect of growing is also very important. Regardless of where and how you grow your orchids, you will need to make constant adjustments to deal with changing temperature, light, air, humidity, pests, etc. The most successful growers are very much in tune with their plants and their growing areas as a managed ecosystem.

Know when to cut your losses. It is probably impossible to identify any single, perfect growing technique for a mixed collection. Even if a lot of your plants do well in semi-hydro, invariably, some will not. Some plants are never happy. Don't sweat the small stuff–revert the ornery plants to what worked for them in the past. If they were never happy in your care, trade with a friend or donate them to the orchid society auction or raffle. No sense wasting bench space on a perpetually miserable plant.

If you're feeling a little adventurous, we strongly encourage you to experiment with semi-hydroponics. Your test subjects should be healthy plants, although semi-hydro is as good a method as any for nursing debilitated plants. With some luck, and this information, your plants will reward you with stronger growth and subsequent flowering. Once you transfer plants to semi-hydro, allow them to establish before making a final judgment on their performance with this method. In many cases, this will take six to 12 months. If they start doing poorly, move them back to their "preferred" mix without hesitation. Regardless of the overall outcome of your semi-hydro experiment, you will certainly learn more about your plants and nuances of your growing technique, so even if you switch back to another method, you'll be a better grower in the end.✾

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About the Author

Ernie Gemeinhart is the owner of EnLightened Orchids and an accredited AOS judge at the Florida North Central Judging Center. Working as a laboratory manager for the NanoScience Technology Center and Advanced Materials Processing and Analysis Center labs at the University of Central Florida pays the bills, puts food on the table, and keeps orchids on the benches. He travels extensively lecturing on many topics including growing under fluorescent lights, semi-hydroponics, and paphiopedilums among other topics. His son, Logan, routinely helps repot and water plants in semi-hydro with great efficiency. Yes, even a four-year-old can grow with semi-hydro!

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