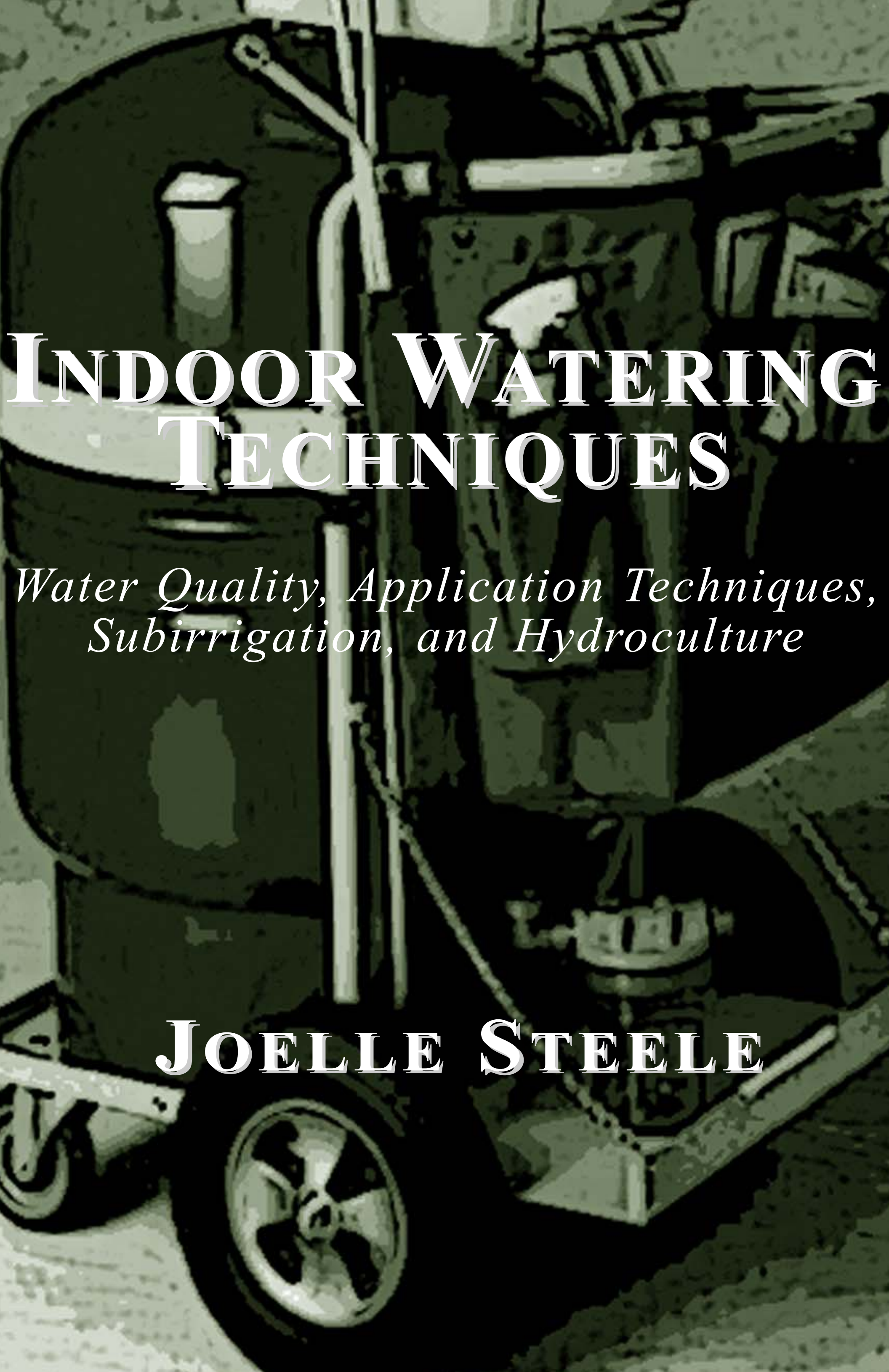

Indoor Watering Techniques

Water Quality, Application Techniques, Subirrigation, and Hydroculture

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Indoor Watering Techniques: Water Quality, Application Techniques, Subirrigation, & Hydroculture

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INDOOR WATERING TECHNIQUES
Water Quality, Application Techniques, Subirrigation, and Hydroculture

The most common causes of indoor houseplant fatalities are related to improper water quality and poor watering techniques. This book explains what's in the various kinds of waters available for use on plants and their effects on house plants. It also explains the correct way to water indoor plants manually and the latest in high-tech watering systems for indoor plants, including subirrigation systems, hydroponics, and hydroculture as alternative methods for growing plants indoors.

* * *

Even the most experienced gardeners have difficulties keeping their house plants properly watered. Watering a plant outdoors is relatively easy. Outdoor plants and trees receive their water from different sources: rain, fog, underground water tables and runoff, man-made sprinkler systems, and hand-held garden hoses. You do not usually have to measure the amount of water applied outdoors since any excess will simply run into the water table or will evaporate under the noonday sun. Chemicals do not usually accumulate as they are constantly being leached from the soil. In some colder climates, watering can be suspended altogether during the winter months.

House plants receive their water from only one source: you. And watering indoors is an entirely different story. Excess water remains in the soil, rarely evaporates, and only partially drains into the saucer. Indoor plants are very demanding and unforgiving, and in order to keep them healthy in their artificial environments, they must be watered on an established routine, year round, and they must be watered very carefully, in just the right amount.

Water and Humidity

Water is vital to the life of a plant. It is the main ingredient of protoplasm in which all cell processes occur. It also transports materials within the plant, and its very pressure keeps a plant erect. Most of the water that is absorbed by the roots is later evaporated from the leaves during the transpiration process (loss of water by evaporation, primarily through the stomata/pores of the leaves), which provides a source of humidity and cooling of the air indoors.

Water is also present in the air. The concentration of moisture or water vapor in the air is called humidity. Relative humidity is the ratio of water vapor in the air at a given temperature compared to the maximum amount that the air can contain at the same temperature. Relative humidity influences transpiration which increases when relative humidity is low and decreases when it is high. It also affects the outbreak and spread of many plant diseases that thrive in a moist atmosphere, particularly when air circulation is poor.

Because indoor environments are usually rather dry (relative humidity is low), plants transpire rapidly. Many people try to increase the humidity of a room or a plant by misting. Misting means spraying water into the air around a plant. Misting can be a problem if it is done too frequently or if the misting takes the form of a miniature rainstorm instead of a light spritzing. If you feel that you must mist a plant, do it only when the air is dry and warm, use tepid water, and do it early in the day so that any drops which fall on the plant surface can evaporate quickly and not damage the tissue.

When humidity is very high and a plant is unable to transpire, it may guttate. Guttation is the process by which a plant releases liquid water from within itself onto a plant surface such as a leaf. The water may contain calcium salts which dry into a white crusty material at the leaf margins. Morning dew on your lawn is an example of guttation.

Water Temperature

Water, particularly tap water, can change temperature according to the seasons. However, watering indoors in the summer rarely results in a problem because the water doesn't heat up to a dangerous level. Winter, on the other hand, can be a real problem. Cold water applied to plants results in reduced root temperatures which cause the roots to function poorly, most often being unable to absorb and utilize the water. This is particularly so when watering with cold water in a room where the plant's soil surface is warm from sunlight or from heating. These problems can be avoided by using room-temperature water.

Water pH

One of the most important factors determining water quality in relation to its effects on plants is pH, the acidity or alkalinity of a substance as measured by the pH scale. Using water with the improper pH level can damage plants and is the most common cause of foliage problems. To measure the pH of the water you need a pH testing kit (available at most drug stores and garden centers) consisting of Nitrazine paper strips which are inserted into the water and turn the paper a color which corresponds to a number on the pH table.

The pH of water is a measurement of the relationship of hydrogen ions to hydroxyl ions. The pH scale ranges from 0 to 14, with 7 being neutral. Above 7 is on the alkaline side which means that there are more hydroxyl ions than hydrogen ions. Below 7 is on the acid side which means there are more hydrogen ions than hydroxyl ions. Most foliage plants prefer to be slightly on the acid side, with soil and water pH ranging between about 5.5 to 6.5, which is where there are more hydrogen ions than hydroxyl ions, and fertilizers are most readily available to the plants.

Water with high alkalinity always has a high pH level and is called “hard” water. Water with a high alkaline content is also called “basic” water, but is also more commonly referred to as hard water. Alkalinity is determined by the calcium and magnesium content of the water, and is a measure of the water’s capacity to neutralize acids. High alkaline content means that the water contains alkalis such as sodium and potassium. Not all water that has a high pH has a high alkalinity level. The growing media pH could register a higher pH level because of high alkaline, but not alkalinity. Therefore, if you try to acidify a water that has both high alkaline and high alkalinity, you will be able to reduce the alkaline, but not the alkalinity. High alkalinity interferes with the absorption of plant nutrients, and high alkaline content can cause a plant to lose leaf color and exhibit stunted growth.

Highly acid water contains toxic levels of metallic ions and produces wilting and abscission (leaf loss) in plants, but it is unlikely that it would be used as a source for watering because it often has a foul odor that would be offensive to the people who live or work nearby.

If your water source has a high pH level, it can be made more acidic by adding vinegar to the water, or by treating the water with nitric, phosphoric, or sulfuric acid. If the water is very hard with high alkalinity, and the carbonate content is high (which it usually is), more acid will be needed to effectively lower the pH. Acid should only be added to the water if it has been tested and shown to be overly alkaline. Changes in water and soil pH should be made gradually and should be tested with a pH meter or litmus paper.

Occasionally, you may want to make an acid water more alkaline, as when maintaining cacti and succulents, which usually prefer a more alkaline water. This can be achieved by adding baking soda to the water, but this should only be done if the water tests as acid, and it should be done gradually.

Water Damage

Many symptoms of water damage mimic those of bacterial, fungal, or viral disease. A plant diagnosed and treated for a nutritional deficiency may be suffering from water damage, in which case the incorrect treatment exacerbates the condition. Plant disease can destroy a plant when the water contents have lowered the plant's defenses. The same is true with pests that devastate a plant that has been weakened by exposure to the wrong pH.

The best defense against misdiagnosis and resulting plant fatalities is to know what is in the water. It is not the only answer to problems of diagnosis, but it is one step that is frequently overlooked at the expense of a valued plant.

Water Types and Their Effects On Plants

Carbonated. Contains the same amount of carbon dioxide that it had at its source. Also called sparkling water. Should not be used on plants.

Chloramined. In some states, chloramines are added to the water supply in place of chlorine. These have not shown to be harmful and reportedly break down into an ammonia, which provides nitrogen.

Chlorinated. There may not be sufficient chlorine in a city's water to cause plant injury. But, to be on the safe side, let the water sit for 24-48 hours so the chlorine can dissipate. Excessive amounts may stunt plant growth. Plants located around chlorinated pools or fountains may have yellow and dying leaves.

Cold. This may cause spotting and mottling of the leaves of philodendrons and syngoniums to name a few. Drawing water from the warm water tap (before it gets hot) or using water that has been boiled and then left to stand and cool will result in fewer chemical impurities.

Fluorinated. As little as 0.10 parts per million (ppm) fluorine can cause toxic damage to plants, and some city water supplies have as much as 1.0 ppm in them. Like chlorine, fluorine can be removed by letting the water sit for 24-48 hours so that the chemical can dissipate.

Fluoridated. Also found in some fertilizers, peat, vermiculite, and perlite. Up to 2 ppm in city water is harmless unless there are fluorides in the soil from fertilizers, etc. Damage is brown, dead, spots along leaf margins and tips of older leaves. To minimize damage, maintain soil pH at 6.0-6.5. Atmospheric fluoride causes yellowing, brownish discoloration, and dead leaves.

Hard. This is highly alkaline and contains soluble salts which concentrate in the soil and may injure the roots or stunt the plant's growth.

Mineral. Contains not less than 250 parts per million total dissolved solids, usually coming from a spring or other underground water source. This may taste good but it is not suitable for use on plants because of the excessive mineral content that can build up and cause root damage.

Purified/Bottled. Any water that has been produced by distillation, deionization, demineralization, reverse osmosis, or other process that meets the definition of purified water in the United States Pharmacopoeia. Safe for use on plants.

Rain/Tap. Varies from one area to another. In acid rain locales, water will have whatever acid is prevalent in that area. Damage to plants may occur according to the type of acid and its levels in the water. Your local water company can provide you with an analysis of your water on request.

Salt. True sea water or water to which salt has been added. The total salt content of water is determined by using a solubridge to measure its electrical conductivity. The more electric current it conducts, the saltier the water. Not for use on plants, even at low salt levels.

Soft. More acidic. May contain sodium and other salts. If water was processed using the cation-exchange method, it may be very high in sodium, which means an increase in soluble salts. Excess sodium can cause the soil structure to deteriorate. Water softened by cation-exchange should not be used on plants.

Sparkling. The same as carbonated water.

Spring/Well/Artesian/Natural. As good as the spring or well from which it is drawn, spring water is usually supplied by a bottler, and their analysis should be obtained before using.

When To Water

Determining the frequency of watering cannot be learned by memorizing facts, figures, or formulas alone, or by relying on the simplistic watering guides provided by many plant care books. Those watering guides are highly inaccurate and they are absolutely no substitute for learning how to water correctly.

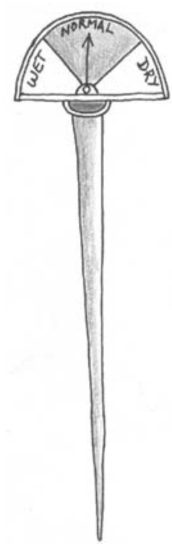
The first step to learning how to water is learning when to water. You can't just walk into a room and automatically pour two cups of water into a plant or saturate a plant with water or ignore it completely. You have to take the time to assess each plant and determine whether or not it needs water, and then how much. Learning to do this doesn't happen overnight; it takes time and practice.

Finger Testing. Testing the soil with your finger is one way to determine whether or not a plant needs water. The top 25% of the pot is the part your finger will usually be able to test, with the exception of some very large containers. If those upper inches of soil are hard and cracked you have definitely waited too long between waterings. If they're dry and particles can be easily brushed from your fingers, it is time to water. If the soil is very moist (not merely cold), and if the particles stick to your fingers leaving a residue, it is too soon to water. Wait a day or two and check again, or if you only visit once a week, water very lightly.

Using Your Eyes. Finger testing alone is not sufficient. Using your eyes is very helpful. Water pressure within the plant tissues causes turgor, the ability of the plant to stay erect. As the plant uses up its water the leaves become a little less erect. This is a very subtle change to which you can become aware using your powers of observation over time. Each plant is a little different and you will eventually become accustomed to those differences and be able to determine watering needs without the need to dirty your fingers.

Checking Pot Weight. If your eyes and fingers haven't given you enough information to make a decision about whether it is time to water, you can also try tilting the container a little to determine how much water is in the soil. If the pot is heavy, the soil is likely to more wet than dry; if it's light, it's probably more dry than wet.

Using A Moisture Meter. In addition to the above methods, you can also use a moisture meter or tensiometer. But before you invest in one, you must learn how to use it and you must be aware that it can fail to be accurate if you don't.



To obtain an accurate reading on a moisture meter, it must be inserted into the soil in a few different spots (being careful not to hit a root in the process). In large containers, a meter may not probe deeply enough and will read only the top levels of soil, resulting in water being added when not needed.

Moisture meters measure the soluble salts found in soil. When those salts are not suspended in water, the meter indicates that the soil is dry. However, if the plant has been recently fertilized or is overfertilized, the meter may still give a high soluble salt reading even if the soil is very moist. In addition, soil that is highly compacted may influence the reading. The more compact the soil, the more likely that the meter will read the soil as wet when, in fact, the soil may be bone dry. And, if you have been watering with distilled water, your meter may register "dry" even if the soil is very moist.

As you can see, moisture meters are not always reliable. In addition, once they have been in constant use on the job for a period of about a year – or even less – the sensing portion becomes eroded and no longer functions properly. The best way to use a moisture meter is in combination with your fingers and your eyes. A moisture meter is just one tool – and not the only tool – for determining when to water.

Container Size and Soil Condition

As a rule of thumb, plants should never be allowed to dry out completely or get so dry that they reach their permanent wilting point, at which they will not recover from wilting unless water is added to the soil. Most plants do well with moderate moisture levels if they are not over-fertilized and if they are growing in a well-aerated media. Be sure that plants are in the right size pot, and that they are not pot-bound or in a container that is too large. In general, approximately 25% to 35% of a container's soil should be free of roots, especially on the bottom and the sides, and about 10% of the soil on top should be free of roots as well to allow for proper leaching. A "root-to-shoot" ratio of 1/3 roots to 2/3 shoots is ideal in most plants.

Remember that as a plant grows older, the soil becomes compacted and, depending on the composition of the soil, can become either waterlogged and unable to drain properly, or can become rock-hard and almost incapable of absorbing water. Transplanting into the same container with fresh soil, or transplanting up a size if required, can give an older plant a new lease on life. Fresh soil allows a plant to be properly irrigated and allows air to circulate throughout the roots.

Watering Frequency

Before you can establish a watering schedule, you need to know how frequently to water, and frequency is determined by the water requirements of individual plant species, their environment, and the type of growing media. In general and whenever possible, water lightly and more frequently rather than watering heavily and less frequently. During the first few weeks of maintenance, it is a good idea to schedule more frequent visits in order to gauge the correct watering routine for each plant.

To ensure that plants always receive the necessary amount of water to keep their optimum health, you must adhere to a regular maintenance schedule. This can be from once a week to once every two weeks. However, once a week is the minimum in most cases. If plants are checked weekly, some will need water and some won't. If you only check every two weeks you may cause water deprivation stress to those that require a weekly watering.

Plants need less water during periods of dormancy when the days are shorter and there is less light available for the photosynthetic process. During these times you will need to cut back on the amount of water and, possibly but not necessarily, the frequency of the watering. However, many people crank up the heat in winter, and if plants are kept in very warm rooms as a result, any water applied to them may evaporate, so you should not cut back too drastically without double-checking the plant the following week.

Individual planting environments will dictate the frequency of watering as well. Plants installed in areas with high light levels will need more water, more so if they are in direct sunlight or if the air is very dry or hot. High light levels are often accompanied by heat, so as a rule of thumb, these areas will need to be watered more frequently. In the summer, doors and windows are often left open or air conditioners are turned on. Plants sitting in warm windows could burn, plants near air conditioning vents could suffer cold damage, and plants in air-conditioned spaces in general could require more water because the air is so dry.

Watering schedules must be calculated on a client-by-client, plant-by-plant basis. If you do not have time to adequately water plants – and tend to their other needs as well – you should advise your employer of exactly how much additional time you need to do the job properly.

How To Water

There are three basic ways to water a plant: top watering, bottom watering, and subirrigation. Bottom watering is simply putting water in the plant's drainage saucer and letting it be absorbed and drawn up into the soil and into the plant's root system. This process causes flushing, the washing of soluble salts upward where they are deposited on or near the soil surface. Subirrigation also flushes soluble salts upwards. It is a process using a wick or sensor device inserted into the soil to draw moisture in from a water reservoir by means of capillary action.

Top Watering. Top watering is the most commonly used method of watering indoors. It simply means pouring water onto the soil surface of the plant and letting the water penetrate the deeper layers of soil nearest the root system. This can be done manually with a bucket, hose, portable water tank, or drip irrigation. With top watering, soluble substances from the upper layers of soil are leached through the lower layers of soil (where the roots are), and eventually out of the drainage holes of the container.

Since you will usually not have a hose when you water, you should use a straight-spouted watering container, not one with a sprayer head on the spout. Sprayer heads can splash water on the plant and leave brown spots when the water doesn't readily evaporate and the tissue surface gets soaked and rotted out wherever the water drop was. Because plants cannot replenish or regrow damaged tissue, that unattractive brown spot will always be there.

When top watering manually, you should always cover the soil surface and not just pour water in one spot each time. Remember that the roots are spread out all over the insides of the pot and depriving even a small section of them from moisture can cause damage to those roots, which will later be exhibited in the foliage itself.

If a plant has dried out completely between waterings, you may have to take a little more time watering it. If you are accustomed to just pouring the water over the soil surface and then moving on to the next plant, you will have to slow down. A plant that has dried out will not readily absorb added moisture. The water may just sit on top of the soil or it may run down the gaps between the soil and the sides of the pot and out the drain holes. In that case, you may have to submerge the entire pot in water until it has the time to absorb moisture more thoroughly. Usually two to three minutes is enough time for a small pot, five to ten may be necessary for a large tree.

Unfortunately, when maintaining plants indoors, top watering cannot always be as effective as it should be in theory. Water is not usually leached thoroughly through the medium and salts can build up and damage the roots. The medium may be moist, but the build-up of salts from fertilization can still occur. In the alternative, sometimes water shoots right through the soil and is left in the saucer where it sits until the roots are gradually rotted. This all makes top watering a practice that is not easy to master.

Drip Irrigation. Drip irrigation is an automated form of top watering in which water is applied by a variety of methods such as controlled-drip emitters, mini-sprayers, soaker tubing, and in outdoor environments, sprinkler systems. Drip irrigation indoors is usually limited to low pressure, low volume water delivery. There is no runoff or loss from evaporation because the water is applied very slowly and right on the soil surface beside each plant. Like outdoor sprinkler systems, indoor drip systems can be regulated on a plant-by-plant basis by using different types of emitters which dispense water at various flow rates ranging from 1/2 gallon per hour to approximately 3 gallons per hour. They can be further adjusted by setting the timer for different frequencies and lengths of application.

Drip systems are made of flexible plastic and can be positioned anywhere you want them. They are great for atriums when properly designed. However, when plantings must be irrigated at various levels, it is necessary to use pressure-compensating emitters which will deliver a consistent amount of water throughout the entire system. For most indoor plantings, it is not advisable to use misters or foggers, or any emitter that sprays water, as these can result in foliar damage.

Overwatering. When a houseplant is heavily watered, the water that is not immediately held in the soil will drain out into the saucer. Unless it is extremely warm and the plant is in a very brightly lit location, the remaining water will sit in the soil where it saturates and thereby suffocates the roots (which need oxygen). If the soil does not dry out within a few days time, the roots begin to rot, creating a cozy home for bacteria and fungus to grow. Within a couple of weeks or so, the foliage will begin to wilt and droop, newer leaves may exhibit spots and yellow or black tips, there may be abscission (leaf drop) of new or green leaves and, eventually, complete plant collapse, usually accompanied by a rotten odor. By the time the first foliage symptoms appear, it is usually too late to save the plant. The root damage may be so severe by that time that even transplanting to fresh, dry soil is a futile effort.

Chronic Overwatering. This occurs when a plant is watered just a little too much over a long period of time. The plant exhibits a few symptoms, but not enough to cause alarm. Therefore, it continues to go on being overwatered. At the first sign of a problem, you should check the plant very carefully to see how wet that soil really is. Just because the first inch or so is dry doesn't mean that the roots aren't soaked deep down in the pot, or that a portion of the root system isn't staying moist because a drain hole is blocked.

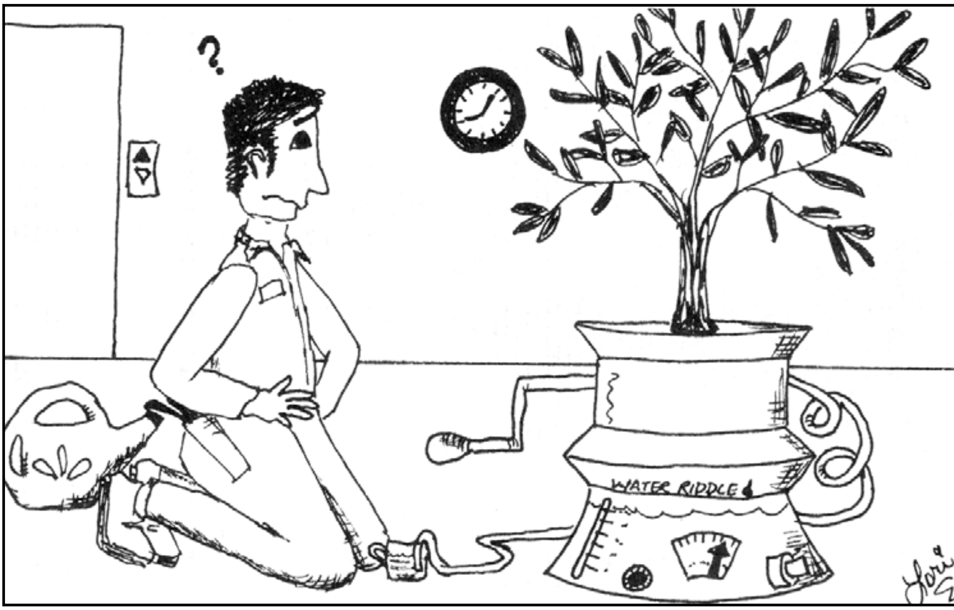
Underwatering. Underwatering is much more common than overwatering, and it can cause long-term damage to a plant and, in extreme cases, death. To an untrained eye, the symptoms of underwatering appear to be the same as those of overwatering. But there are differences. When a plant is underwatered, it wilts and droops, but the older foliage is most affected. Those leaves turn yellow first and then brown, and their tips and margins turn brown. In cases of chronic underwatering (the most common form of underwatering, when plants are regularly not given sufficient water over time) these symptoms may be interpreted as leaves getting old and dying. But, with indoor plants in reasonably good light, leaf loss should be minimal at best. If a plant is always losing its older foliage, rest assured, something is definitely wrong, and it's probably underwatering.

To reverse the problem, begin increasing slightly the amount of water applied until the symptoms cease. But, remember that the damage that is already apparent will not go away or repair itself. It takes a few weeks just for the leaf loss alone to cease, and you should carefully groom the foliage so that you can easily see whether any new damage is occurring.

Subirrigation

To avoid the problems of over- and underwatering, nothing is better than subirrigation. It is leading edge technology that's been around long enough to have had the "bugs" worked out of it, and it has a long and proven track record. Everyone can use it. Plant losses can be reduced dramatically with these systems because they almost entirely eliminate the majority of watering-related problems. It is therefore well worth the short amount of time it takes to learn how to use them properly.

FOLIAGE FUNNIES Lori Woodhall



"I just want to know where I'm supposed to fill this 'self-watering' planter."

Tips for Subirrigation Users

Most of the problems that technicians have with subirrigation systems are a result of improper planting techniques. Most subirrigation systems require close attention to such details as the elimination of air pockets in the soil. If there are air pockets left, the system may fail to function.

Whichever system you use, pay strict attention to the manufacturer's instructions and contact them for support if necessary (most have toll-free numbers and web sites). Each system has a preferred soil or media that has been found to work best and a few fertilizers that are most effective. To ensure that a system works properly, follow the manufacturer's advice in these matters.

During the first few weeks following installation, plants use more water than normal. Monitor their water levels carefully each week, even twice a week for the first month or so, until you get a feel for the amount of water that they use on a regular basis. If you are using a system that requires a drying out period and it is running a little low during a dry spell, make a point of checking the plants more frequently during that period.

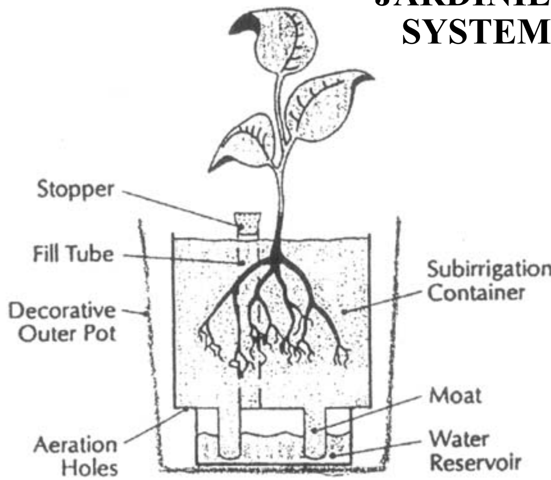
If plants take a sudden turn for the worse while installed in a subirrigation system, don't make the mistake of assuming that the system is faulty and doesn't work. It is more likely the result of an installation error that can be easily corrected without plant fatality. It could also be a non-system problem altogether, such as a sunburn on a plant left in a hot window on a warm day, a lack of air circulation in an unventilated room, or a foreign substance spilled into a plant by a party guest, a careless employee, or a janitor.

Subirrigation Systems

Everlife Subirrigation System. This company that manufactured and/or sold this system is no longer in business, but the product is occasionally found on older installations. Everlife is similar in concept to Jardinier. These containers, which came in several sizes, could be adapted to fit inside a wide range of deco containers, could be used as a closed system with no drain holes, or an open system with either drain holes at the same level as the system's disk or at the bottom with a saucer under the planter acting as the reservoir. The system requires a drying out period. Uses a dip stick in the fill tube. Refill when the dip stick measures empty.

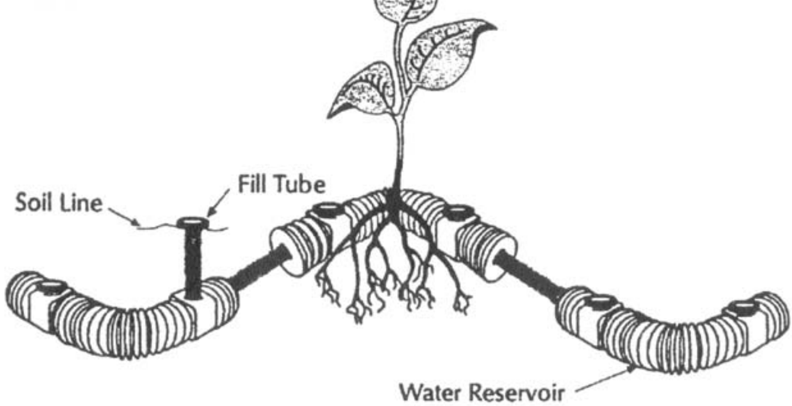
Jardinier Subirrigation System. The company that manufactured and/or sold this system is no longer in business, but like the Everlife it is still found on older installations. The Jardinier is a container system but can also be used in built-in planter beds. Consists of a reservoir, a moat (which you fill with perlite), a water intake tube, and aeration and drainage holes. Moat and water intake tube are a single component that fits into the container. That entire system then drops inside most deco containers. Requires a drying out period, and a "dip stick" in the water intake tube will register empty when it's time to refill.

JARDINIER SYSTEM



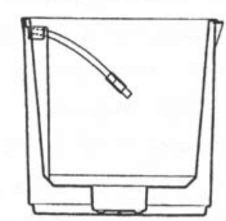
MPS Capillary Irrigation System (MONA). This is a system of flexible reservoirs that can be linked together to fit inside any shape container or planter bed. Fills through a tube that runs from one of the reservoirs to the soil surface. Extremely

MPS / MONA SYSTEM

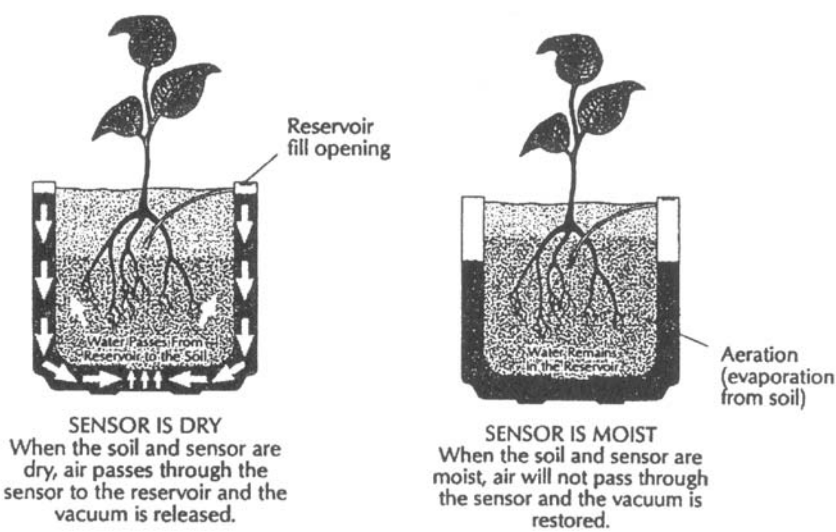


versatile but requires a degree of skill for installation. The reservoirs act as natural water tables accessed by capillary action. Soil remains consistently moist but never saturated, and is aerated via vents on top of the reservoir. Requires a drying out period before refilling. Fill when the float in the tube is at the bottom of the tube and the top two inches of the soil surface are dry.

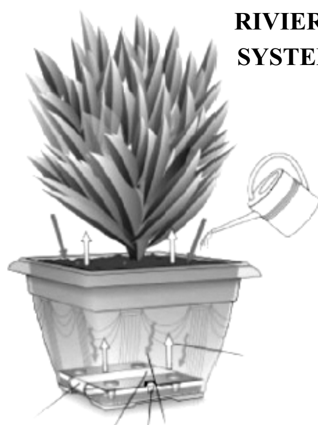
Natural Spring Controlled Watering Planters. These award-winning planters have been around since about 1981. They are fully enclosed and consist of a reservoir that encircles the container and is vacuum-sealed with a cork. There is a porous sensor attached to a tube which is inserted into the soil, and inlet holes in the bottom of the container allow water inside when the sensor is dry. There is no drying out period and no measuring of water levels prior to refilling the reservoir. The containers can be "topped off" at any time. Do not let these containers dry out.



NATURAL SPRING



If the container overwaters, the top layer of soil will be wet or damp, and the plant may show signs of overwatering. Be sure the cork is in tight, that the soil is packed firmly, and then place the sensor a little deeper into the soil. Try not to remove the cork every time you visit. Instead, tap on the side of the container or tilt it to judge the water level in the reservoir. If the container underwaters, the water level will not drop between fillings and the plant will show signs of stress. The soil should be damp about 2” (5cm) below the top level of soil. If it isn’t and if the plant is being underwatered, remove the cork for about 5 minutes to see if the water level in the reservoir goes down. If it does, top water lightly and/or adjust the sensor by raising it a little bit higher and packing the soil firmly around it.



RIVIERA SYSTEM

Riviera Self Watering System. This system allows watering at the top of the tank (at the plant's base) without overflowing. When watering, the air held in the water reservoir is pushed away by the water flowing in. The planter is watertight, so air goes upwards and aerates the soil. There is a fabric wick system which leads the water to the soil. Do not fill the reservoir above the top of the level gauge. Check the gauge weekly. When the soil is dry, water again.

LUWASA SYSTEM

There are many other subirrigation systems available that work in similar ways, each with slight variations in structure and use. For example, there is the CWI Container Irrigation System, a free-standing, closed system container that has larger reservoirs to allow for longer intervals between refilling, and there are the Luwasa and Lucheza systems.

Living Walls

Interior living walls, also called green walls, vertical gardens, and bio-walls, were in widespread use in Europe and Australia for several years before they found a place in the interior landscape industry in the United States. They are used for both their aesthetic appeal as well as their ability to provide a larger decorative planting space and to humidify and purify the air in indoor environments. Living walls are just what the words sound like: a wall covered with plants.

G-SKY Living Wall

Living walls come in many configurations. Some are composed of modular panels laid out in grids. They are constructed of materials such as plastics and wood, and they can be custom-built for a specific wall space or they can be purchased in pre-made sizes and linked together to fit in most indoor environments.

Living walls are installed vertically next to, or attached to, indoor walls. They are composed of sections or cells which house a growing medium of geotextile fiber or foam resin. The manufacturers provide instructions for installation of their living wall systems. Plants are rooted in the growing medium and water is filtered and circulated from the top to the bottom of the walls, usually through a combination of drip irrigation and/or a system of cells through which water flows from cell to cell and panel to panel. Some living roof systems can be adapted for use as indoor living walls, and other types of living walls are nothing more than a system of steel or plastic shelving in a grid form filled with individual potted plants.

The best plants to install in modular indoor vertical gardens are pothos, coleus, hoyas, cordatums, guttiferums, syngoniums, peperomias, cissus, marantas, and aeschynanthus. Any low-growing or "crawling" plants that are suitable to the lighting of the environment are viable options for a vertical garden. The manufacturer of the living walls system you use should be consulted for their recommendations for successful plant installation.

Following the installation of the plants, they can be watered as needed on a regular basis, usually by filling the uppermost drip tray from which water flows evenly throughout the panels. Some systems contain individual cells that have water reservoirs that hold water which flows through the panels. The panels can also be adapted to use as hydroponic systems, although these require a constant water source. Unlike most interior plant systems, living walls do not rely on potting mixes and soil, so they will usually require regular fertilization.

Hydroponics & Hydroculture

You might not ever come across a hydroponic or hydroculture system in the interior landscape, but you never know. It is a very old yet highly effective technology that you may want to experiment with some day.

Cultivating plants in water (“soilless gardening”) dates back centuries. The Aztecs grew flowers, trees, and vegetables on “chinampas,” floating rafts covered with rich organic debris from the bottom of Lake Tenochtitlan. The roots of the plants grew through the floors of the rafts and into the water. These floating gardens, the rustic forerunners of today’s sophisticated hydroculture and hydroponic systems, were still in use on Lake Tenochtitlan during the nineteenth century and similar systems are in use in the Middle East to this day.

The technology behind hydroponic gardening has been known for over a hundred years, but it was not until the mid-1930s that Dr. W.F. Gericke of the University of California, growing tomatoes in water, brought the practice into the home garden. He was also responsible for coining the name hydroponics from the two Greek words: "hydro" meaning water, and "ponos" meaning labor or work.

The interest in hydroponics during the 20th century's Great Depression era was insignificant. But, just a few short years later during World War II, American soldiers stationed in Pacific island environments turned to these methods for growing vegetables. Today, hydroponics is a big business commercially throughout the world and is enjoying an even greater interest by home gardeners since it became more simplified and readily available to the general public.

Hydroculture Today

Today, NASA shares its once-proprietary hydroponic technology with American farmers, and some scientists believe that hydroponics can be affordable enough to eventually dominate the agricultural industry, especially in the growing of sensitive crops, such as baby spinach, which is sensitive to root zone diseases during the germination stage in traditional soil media. Hydroponics is already in use for small-volume food production in outer space and in non-agricultural areas such as Antarctica, and the ornamental market uses it for high-value flowers and other greenhouse crops. Clearly, hydroponics and hydroculture are cutting edge technology and should not be dismissed as overpriced fads.

To some, the very idea of growing a plant without good old-fashioned "dirt" can seem somewhat unnatural. After all, we are so used to seeing plants growing in soil that it would appear a plant cannot grow properly without it. But, plants do not require soil at all. In fact, plants grown in water alone (true hydroculture), and those grown in hydroponic systems (containers or units filled with water and such non-soil media as crushed rock or vermiculite) are actually healthier and more attractive than most of their soil-grown counterparts.

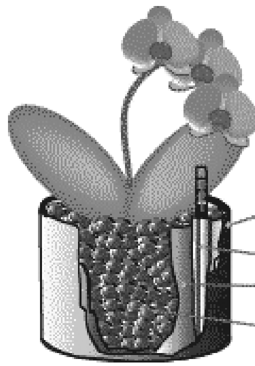
Hydroponics, or soilless gardening, offers many benefits to gardeners. The sterile medium eliminates soil-borne pests and diseases as well as weeds, and drastically reduces the need for toxic chemicals and pesticide controls. There is rarely a cause for concern about adequate humidity since the water supply provides it automatically (although the dry artificial heat used indoors during the winter can be harmful and some pebble trays or a humidifier may be helpful).

Hydroponic gardening takes the guesswork out of watering and fertilization. Exact amounts of nutrients are given at specific intervals and the plants use whatever is given them. Nothing is ever leached out of the root system as happens with traditional soil systems, the roots do not grow as extensively in water as in soil, and the plants grow faster (by at least 20 percent). They also take up less room and can be grown in individual pots and containers of whatever size, shape, or configuration the available space dictates.

For beginners, basic hydroculture or water culture makes an inexpensive introduction to this method. One or two plants, (of the same or different species), are displayed in containers filled with water and nutrient solution. More advanced systems may contain supportive materials such as charcoal or gravel.

Hydroponic Containers

While most hydroponic containers are manufactured in Europe where these methods are well-established practices, there are a few reliable sources for units in North America. However, for true water culture, almost any heavy-weight, clear glass container of any shape or configuration can be used. For plants which require more support than water alone can provide, a layer of crushed rock in the bottom of the container should give the roots a foothold. Charcoal from your aquarium dealer can be used and has the added advantage of deterring the growth of algae, a harmless but unsightly mossy plant which sometimes covers the insides of the glass container, particularly if it is in a warm, sunny window. Charcoal can always be used as the bottom layer under such decorative support media as marbles and aquarium gravel.



Containers and any support media must be thoroughly sterilized before introducing plants and water. Scrubbing with hot soapy water should do the trick. If you decide to plant a mature plant in water, rather than rooting a cutting, you must also remove all traces of soil from the plant. Very gently and carefully clean the roots using lukewarm water to rinse them off thoroughly. Afterwards, place the plant into the container and slowly pour the water around the roots until part of the stem is under water. If the leaves get wet in the process, be sure to blot them dry with a soft cotton towel.

Hydroponics and Water Quality

Because the purity of the water is important, it must be replaced at least once every four weeks. If algae forms in between these changes the container must be scrubbed out and all traces of the algae must be removed before replacing the water. To help cut down on algae, you can try reducing slightly the amount of fertilizer you are using. And, whenever the water level drops between monthly changings, add a little more water. But, only add fertilizer when you completely replace the water each month.

Water pH should be checked weekly. A pH reading between 6 and 7 is fine for optimum growth and development. When the pH is not within those levels the plant may not be able to use its nutrients. You neutralize an alkaline water by adding either drops of vinegar or grains of aspirin and retesting with each drop or grain added until it reaches the proper level. If the water becomes too acid, it can be neutralized using the same process but substituting bicarbonate of soda for the vinegar.

Chlorinated water affects pH levels so you should let the water stand for 48 hours until this chemical dissipates before filling your containers. Other potential water quality problems can occur if you use soft water, which should never be used on plants grown in water (or in soil). And, if you decide to use a hydroponic system which collects drained-off water and nutrient solution, it should be reused only for a short period of time, three or four days at most.

Water Culture Fertilization

Plants grown in water culture require nutrition in the form of fertilizer. With hydroponic systems, almost any plant food can be used as long as it is water soluble. In addition, the manufacturer's package should state that it is a "complete fertilizer" and that it is specifically formulated for the kinds of plants you are growing. The amount of fertilizer or nutrient solution recommended on the manufacturer's package should be reduced by about one-third for use in hydroponic and hydroculture systems, and it should be added each time you change the water. If you are uncertain about what kind of nutrient solution to make or buy, you may want to play it safe and stick with a fertilizer especially formulated for hydroculture.

Hydroponics and Grooming

As with subirrigation plantings, plants grown in hydroponic systems do not require a lot of care, but they do get dusty and should be cleaned regularly so that their pores do not get clogged and interfere with the plant's biological processes. Also, you should immediately remove any dead leaves that happen to fall into the water or onto the surface of any gravel or other media you are using. Those dead leaves can decay and "pollute" your otherwise sterile system.

Hydroponic Systems

Continuous flow method. In the continuous flow system, three containers are arranged at different levels with the highest containing nutrient solution with a tube leading to the middle container where the plant is located. Another piece of tubing runs from the bottom of the middle container to the lowest container. As the top container empties it is refilled from the bottom one, recycling the water and nutrients. This is a workable system, but may not be altogether practical since it also requires aerating the solution with oxygen.

Swiss method or Plantanova. The Swiss system consists of an egg-shaped container, the top quarter of which lifts off. In the middle is a pebble-covered tray which supports the plant and can be lifted out, and under the tray is the nutrient solution. This system is mainly available in Europe.

Gericke method. This method, named for its inventor, uses waterproof troughs with a wire grid covered with a mix of peat and hay (or sawdust). The plants are stabilized in the media so their roots grow through the grid and into the nutrient solution below with a space for oxygen left between the grid and the liquid.

The following methods use traditional flower pot containers filled with non-soil substances:

Sand culture. This consists of a conventional flower pot filled with sand and water. The drawback is that sand usually becomes waterlogged by itself and in most cases must be mixed with gravel for improved drainage.

Aggregate culture. This relies on gravel, perlite, vermiculite, wood chips, and even styrofoam (though the latter is not recommended for ecological reasons). Gravel or vermiculite are used in combination with sand for water retention and the amount of sand used is determined by the frequency of watering. The less often you want to water, the more sand you use. This method requires some experimenting to find the right combination of materials for your needs, although the use of perlite simplifies matters somewhat since it can be used all by itself.

Flower pot hydroponic systems. These rely on a variety of watering methods. When water is passed through a growing medium and into a drainage reservoir (such as the "gravity feed" and "slop" methods) it is an "active" method. Those methods which rely on wicks or subirrigation are termed "passive" and are covered in the subirrigation section of this book. Gravity feed consists of a bucket reservoir which feeds nutrients directly to the aggregate via a hose. The slop method has a pump that floods the surface of the medium with water which then seeps into the root system and exits through a drain into a container from which the water and nutrient solution can be reused for a short period of time.

It takes some detailed investigation to determine which kind of system you want to use. Budget is certainly one consideration as are the space available and the quantity and kinds of plants you want to grow – herbs, tropicals, vegetables, flowers, etc. You can buy anything from a few simple containers to an entire greenhouse system. As with most things, it pays to shop around and look at the different systems available. Do not buy the first system you see. Wait until you have seen them all and can weigh the pros and cons of each. Who knows, you may even decide against a ready-made unit and enjoy building one of your own design.

Seasonal Care

As autumn leaves fall and winter snows blanket the ground, the days grow shorter and temperatures drop. Indoors, plants feel the effects of these outdoor changes. The lower light levels put a damper on their photosynthetic processes and the result is dormancy. It's a time of change for all plants, and those grown in hydroponics are not all that different. While cooler seasons and artificial heating usually create a substantial drop in humidity, this is not a cause for concern with hydroponics and hydroculture. But, plants grown in soilless media are still faced with the other two biggest problems most indoor plants face with a change of seasons: decreased available light and temperature fluctuations.

Plants are usually grown nearest the natural light sources – windows. Most homes and offices, except for those which are extremely well-insulated, have a few drafty places, and windows are one of them. In the fall and winter, plants should be moved away from those areas to avoid cold damage to the foliage or possible freezing of the water supply. Turning up the heat can make humans more comfortable, but it can trigger a high transpiration rate in plants which can be very damaging.

As a rule of thumb when using hydroponic systems, the lowest daytime temperatures in the plants' environment should stay within the range of 70^{o}-75^{o}F (20^{o}-24^{o}C). They should not exceed 82^{o}F (27^{o}C). For proper plant respiration at night, the temperature should drop by at least 10^{o}, but not more than 25^{o}.

Even though your plants may be dormant during the fall and winter months, you should continue to change the water regularly. However, you should cut back on the nutrient solution by about 1/3 to 1/2 (some believe it should be stopped altogether).

In a heated indoor environment that is humid due to the use of hydroponic containers, there can be a tendency towards mildew and botrytis which occur when there is insufficient or inadequate ventilation. Other diseases such as root, stem, and crown rots, can also occur under the same circumstances. Keep a watchful eye on your plants when the seasons change, as that is the time during which problems of this sort are most likely to occur.