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START UP and OPERATING INSTRUCTIONS Indoor and Balcony Gardens



Critically Important Information

- Use **ONLY** genuine Qplugs and nutrients with MyGarden! Reorder at www.koolsci.com Any soil, dirt, organic matter - any small particles - in the Reservoir will block the irrigation manifold and spaghetti tubes.
- To operate correctly MyGarden must be sloped from back to front and level from side to side. Back to front is built in. If necessary achieve side-to-side using small shims (tiles, thin boards, or similar) under legs.
- Immediately after seeding be careful that Qplugs do not dry. Imbibed (wet) seeds and small seedlings die quickly if their Qplug dries. On some occasions in the first few days you may have to dip a cup into the Reservoir and hand wet the Qplugs.
- You cannot overwater plants in the Garden, and the Garden is quite tolerant of solution flow rate. However there is no need to run the pump in darkness because dark plants require little to no water.
- Empty the Reservoir and replace the nutrient solution on a regular schedule. The solution will last 4 weeks when plants are small but with large plants, which remove nutrients faster, its recommend to change out the solution every two weeks.
- Plants transpire (use water) much faster than they take up the dissolved nutrients. And consider that as water levels drop nutrients become more concentrated. Plants are quite tolerant of varying nutrient concentrations but if water levels drop too low the roots can be damaged. In between nutrient solution change outs maintain the correct level in the Reservoir by adding **water only**. See Appendix B.
- Periodic cleaning is required for all hydroponic systems. Older plant roots decompose after newer roots replace them. Without soil bacteria to break it down this organic matter coats GroPipes, spaghetti tubes and other surfaces. See Annual Clean Out below.
- When placing plants in the Garden try to keep them from shading each other. Position larger growing plants like tomato on the outside and smaller ones in the center. Unless they are huge, you can pull out plants and move them around without damaging them.
- Most food crop plants will keep growing in continuous light although most growers select 18 hours of light daily. Few food crops are truly photoperiodic but some growers note better results with a daily dark period.
- Needle nose pliers gently rescue new seeded plugs that may fall into the GroPipes

Electrical Box

The Electrical Box is a dry, waterproof housing for the timer and connections. Make certain that its interior stays dry as components are neither weatherproof nor designed for outdoor use. There are 3 input cords: Pump, Lamp, and power cord.

The two-outlet timer turns the pump and lamp on and off simultaneously (plants don't need a water source in the dark; see Appendix B). The timer is simple and takes only a few minutes to learn. Use the timer as your on/off switch during nutrient solution change out.

LED Multispectral Grow Lamp

Indoor Garden (standard) and Balcony Garden (optional) when used indoors

Carefully read and keep the Lamp user instructions. Plants use mostly the red and blue wavelengths in the light spectrum [remember a prism or rainbow where white light breaks down into its multi colors or wavelengths?] Plants don't use green, so they reflect it which makes them appear green to you. With LED's today it's possible to provide an ideal mix of plant's favorite wavelengths. This lamp allows for adjustment of the intensity of the red, blue, and white LED's with additional control gained by adjusting hanging height above the plant canopy. Most growers are satisfied to keep the lamp 30" above the GroPipes (the 25" + 11" vertical leg pipes combined). As the seedlings grow they get closer to the light (lamp brochure recommends 25" from the lamp for larger growing plants). If you desire to follow the manufacturers recommendations regarding hanging heights and intensity buy and cut varying lengths of PVC pipe or hang the lamp from the ceiling using the rope and pulley system provided with the lamp.

The manufacturer recommends lamp heights of 28" – 32", 22" – 28", and 16" – 22" for germination and seedling establishment, vegetative growing period, and flowering respectively. Color wise recommendations are 80% B&W and 30% red, 100% B&W and 10% red, and all three colors at fully 100% during the same three growth stages. Note: these conditions were developed for Cannabis and haven't been confirmed for other crops.

MyGarden™ comes with 25 and 11-inch vertical Top Rack legs and a coupling to combine them. We recommend combining them to achieve 30" height above the GroPipes at least to start. That is the recommended height for germination and also seems to work well for growth and flowering. However, you are encouraged to experiment!

Changing out leg heights can be a one-man operation. Place both arms under the lamp, lift slightly, and rock gently to unhook the four corners. Place the lamp carefully on a soft clean surface (its original box works great!). Arrange the legs for the desired height and reverse the operation with the lamp. Hold it with both arms supporting and move it around under the eye bolts until the hooks grab on. Its easiest to hook one side first which will support the lamp's weight while hooking the other side. Smaller, shorter lighter persons may need a helper with this operation.

All plants are different and even different clones of the same plant can differ with regard to ideal light intensity and quality. A good horticulturist can read his/her plants understanding how happy or unhappy they are. Your success will grow with time and experience.

Note – many amateur growers keep it simple and are satisfied with 30" (25" + 11") leg height and never bother to adjust heights (or even light quality) as recommended. But again, you're encouraged to experiment!

The lamp and pump are controlled by the same time clock because plants only transpire (lose water) in the light. Plug both lamp and pump cords into the timer. Plants in vegetative growth will usually keep growing around the clock and some growers set the timer on 24/7. We leave it to you to experiment.

Supplementing Solar Energy **Balcony Gardens in Shady Outdoor Locations (optional)**

Locations in full or almost full sunlight e.g. full southern exposures may need no additional lighting for good crop production.

Note: supplementary lighting nevertheless has two advantages:

1. increases day length when growing during the short days of fall and winter
2. highlights the night time esthetic appeal of attractive Gardens

Balcony Gardens with northern exposure or otherwise insufficient solar intensity require supplementary lighting. Understand how much sunlight plants will receive during a day on your balcony and decide on either one or two lamps. LED lamps are economical so when in doubt choose two. Intensity (measured in Watts) is important but plants need red and blue wavelengths red being most important for photosynthesis so a warm-white lamp with more red is preferred. Adjust the lamp poles so the light is centered over the Garden.

The lamp and pump are controlled by the same time clock because plants only transpire (lose water) in the light. Plug both lamp and pump cords into the timer. Plants in vegetative growth will usually keep growing around the clock and some growers set the timer on 24/7. However the Balcony Garden depends on incident sunlight for its key wavelengths, and the lamp(s) provide supplemental light energy only, and in limited wavelengths. We leave it to you to experiment.

Check for Leaks

Fill the Reservoir to the 4-gallon mark with water only. Set the timer in the on position, make certain that the Electrical Box is tightly closed, and plug the Garden in for the first time. Check the entire Garden carefully for leaks. Leaks cannot be tolerated because they result in loss of nutrient solution (see Appendix A) which will cause your plants to display nutritional deficiencies and grow poorly.

The Garden was carefully designed and tested but leaks can occur in shipping; see Appendix A below for places to check, and ideas for fixing, leaks. Appendix A explains why avoiding leaks is critically important.

Start Growing



Planting & QPlugs

Garden crops are seeded in QPlugs which sit down in the GroPipe GroHoles. Insert one QPlug per hole making certain Plugs touch the bottom of the Pipe. If you purchase seeded QPlugs there will usually be several seeds in each Plug. If you're seeding your own Plugs find the tiny hole in the plug and insert 2-3 seeds about ½" deep. After germination keep the strongest seedling and pinch off the others (although in some cases e.g. lettuce you'll get a nice plant either way). You can grow them to harvest in just a few weeks depending on temperature and the length of the daily light period. To harvest pull the entire plant out of its hole roots and all. You can immediately replant by dropping a new seeded QPlug into the hole.

Watch the Qplugs carefully during the first week or two of germination. Once seeds imbibe water they quickly die if they dry. If Qplugs appear dry pour a little water over them. This is not usually a problem with a properly operating Garden but it is the critical time in the plants life and attention is required. Once the seedling's roots penetrate the Qplugs you will be home free.





As soon as you see green set up the nutrient solution and plan to change it out monthly when plants are small and every other week once they're larger.

Roots

Lettuce, spinach, basil, mint, cilantro, rosemary, cherry tomato and many more plants grow happily directly in GroPipes. We recommend harvesting annuals like lettuce and basil on time – in 4 or 5 weeks - or their root systems may become difficult to pull out of the GroPipe. After harvest plants will stay fresh longer if roots are retained as long as possible in the refrigerator before eating.



Since they're "spoon fed" all their nutrients hydroponically-grown plants have little need for roots but for water uptake. Nevertheless, plants in hydroponics always grow more roots than necessary. Plants staying in the GroPipes longer than 5 weeks require twice monthly root checks. Even large plants can be pulled, checked, and replaced without interruption. If the root system is hard to pull out, and is obviously outgrowing the GroPipe (see illustration below), it should be gently pruned using sharp scissors. Never remove more than 25% of the roots. This sounds complicated but it becomes routine and easy with practice and experience.



If roots are not checked routinely the danger is that they block the Manifold entrance and even the GroPipe causing the nutrient solution to back up. If you find you absolutely can't remove a plant from its GroHole tilt the GroPipe up to completely empty it and unscrew and remove it. Flush it out with a broomstick and garden hose.

Nutrient Solution

Seeds have their own stored food so you can germinate them for a couple of weeks with just water. Once you see green you have to add nutrients. Turn off the pump, fill the Reservoir to the 4-gallon mark, and stir in a 4-gallon bag of nutrients. Flush out the bag in the water to remove all the nutrients. That's it! It's a good idea to check the filter because small plastic dust, undissolved nutrients, bits of plug material, etc. can clog the spaghetti tubes and their manifold. Pull the pump and filter system apart to check the screen, and remove, and flush the screen under running water when necessary. If your pump has a built in filter check and clean that too. To check the spaghetti's simply pull them from their GroPipe entrance holes to ensure they're flowing.

Drain and Fill the Reservoir

Turn off the electricity.

Indoor Garden - Unscrew the Reservoir Return Pipe as shown in Figure 1 and replace it with the Reservoir Drain Pipe to Bucket.

Balcony Garden – On the Return to Reservoir unit reverse the positions of the horizontal pipe entering the Reservoir and the threaded cap on the opposite side of the vertical pipe.



Figure 1 Left - Reservoir Return Pipe; Right - Reservoir Drain to Bucket

Position a bucket and turn the power back on. Tilt the back of the Garden up slightly to get all the solution out of the GroPipes and Manifold. The pump won't remove the last ½" from the Reservoir. Remove the Drain Pipe and pull the Reservoir forward just enough to be able to scoop out the last of the solution. You can make a good scoop out of a plastic milk bottle. If the Reservoir isn't clean rinse it with additional water. Check the filter(s) as indicated above.

Alternatively, if/when the Reservoir really needs cleaning, disconnect the pump and filter assembly and place it outside the Reservoir on top of a closed Electrical Box. Now you can remove the reservoir return pipe and pull out, dump, rinse out with a garden hose, and replace the Reservoir all in just 5 minutes.

Now reverse the operation pushing the Reservoir back into position and replacing the Reservoir Return Pipe. Add water to the correct mark in the Reservoir, dump a nutrient packet into the water, and stir vigorously. Rinse the bag out in the Reservoir to dissolve any remaining nutrients. Nutrients won't dissolve 100% immediately but over time they will all eventually go into solution. Turn the pump back on and ensure that everything operates correctly.

Since plant nutrients remain in the old solution you just removed use the bucket water to fertilize your potted plants and garden. With just a little practice changing out the nutrient solution becomes a simple 10-minute task. Develop a routine and it becomes a negligible twice monthly chore.

When the seedlings are small, and even when plants are large but the operator is unavailable, the Garden can easily go 3 and even 4 weeks without a nutrient solution change out. But the solution level cannot be allowed to drop more than 25%. Maintain the reservoir level **with water only**. Add nutrients only when you do the solution change outs.

The Reservoir is calibrated for 4 and 8 gallons and nutrient packets are available for making 4 and 8 gallons of solution. Four gallons is adequate for seedlings and small plants. When the plant canopy is larger and you find yourself adding water too often switch to 8 gallons. There is no downside to working with the larger volume and a larger volume may even be desirable because you'll be adding make up water less often. The larger volume provides more leeway with both water and nutrients.

Note – nutrients are very hygroscopic i.e. absorb water. If they clump in the bag crush the clumps to really fine particles (hammer the bag!) before dissolving them in the Reservoir.

Water Acidity (pH)

Water acidity, which varies greatly from region to region, influences gardening success by affecting the uptake of individual nutrients. See Appendix B for a more detailed explanation and for a discussion of pH (the measure of acidity) and the Garden™. Crops differ in their preferred pH; a medium solution pH around 5.5 is closest to ideal to accommodate most food crops. If your water pH is high, 7 or above, adding a cup of white vinegar to the Reservoir will lower it quickly and improve nutrient uptake. Usually, however, the solution pH will quickly drift back higher. If you're having problems or are simply curious ask your water supplier for your water's pH or have a sample tested at your County Agricultural Extension Office or at almost any laboratory including high school chemistry labs. Find your local Extension Office on our website www.Koolsci.com/shop

Clogged Spaghetti Tubes

This is not a usual problem in a properly operating Garden with Reservoir kept closed. It's imperative to keep the Reservoir and the nutrient solution clean to prevent small particles from clogging the irrigation system spaghetti tubes. Note the filter inside the Reservoir in the Pump and Filter Assembly. If spaghetti tubes block first check that filter. It's a good idea to check that filter periodically during nutrient solution change outs. Pull the Assembly apart (fittings are not glued) and clean the small copper screen under running water.

If you encounter a clogged spaghetti tube you can try sucking hard on it and spitting out the solution, or running a fine wire through it. If that doesn't work simply replace the tube. Replacement tubing is included, and available at www.koolsci.com

Slow nutrient solution flow is adequate but if flow gets too slow you may have a problem. Check the pump by pulling the Pump and Filter Assembly apart inside the Reservoir. Particles may be clogging the pump intake. Next check the spaghetti tubes. Particles of any kind in the nutrient solution can clog the tubes. In that case follow the advice in the paragraph above.

Pest Management

You should not encounter insect problems indoors. Early on you won't experience disease problems either which, however, can build up over time due to accumulation of small bits of dead and decaying plant material. When a GroPipe is empty, and before replanting it, remove it from the Garden and clean the inside with a garden hose and rag ball on a broomstick. Finish by pouring a thin layer of dilute bleach solution through it covering all the inside wall.

Annual Clean Out

Older plant roots die and slough off replaced by new roots. In soil this organic matter is quickly broken down by natural bacteria but in hydroponics it can build up and encourage root disease causing bacteria like Pythium. Once a year or more frequently under intensive growing conditions its good practice to thoroughly clean the Garden. Remove the GroPipes, take them outside, and flush them out with a garden hose. Run water through the manifold and use a rag to wipe out the Reservoir. Replace the spaghetti tubes or run a wire through them to clean them out. Use a razor blade to cut them off the manifold (they don't easily pull off). Wipe down all exterior surfaces.

If you encounter root disease problems, you'll have to run a dilute bleach solution through your system once you complete the above clean-up. Bleach is not toxic to plants and is easily rinsed away after treatment. All this sounds like lots of work but its only a fun hour on a pleasant sunny afternoon. Your plants will thank you!

Have Fun!

The Garden is freestanding, independent and easy to operate but it does require just a bit of practice, attention, and effort to maximize success. You'll enjoy it most if you like plants, technology, and growing and are willing to dedicate at least some minimal time to the hobby. The Garden is an excellent platform for creating, designing, and testing for fun, or for competing in science fairs. Environmental, nutritional, and technical factors can all be altered to determine the effect of alteration on plant growth, development and/or productivity. The platform is composed of easy to alter off the shelf parts making it perfect for experimentation. See some project based learning (PBL) ideas on our website

www.koolsci.com/classroom



OPTIONS

Increase the versatility of your Garden:

Spring Start GroPipes - 15 holes/GroPipe for getting a jump on your spring backyard garden plantings

Frost Protection System – Extend your growing season in the north and grow all winter in the south

Lighting (described above) –

LED full spectrum lighting for Balcony Gardens used indoors (standard on Indoor Gardens)

Supplementary lighting (one or two lamps) for Gardens on shaded balconies

Appendices

Appendix A: Leaks and the Loss of Nutrients

The nutrient solution is composed of water and 13 essential elements that plants require for growth and development. Plants use lots of water to cool themselves through transpiration under hot lights, water that must be replaced. In full sunshine, a large tomato plant transpires more than a gallon of water a day. Plants take up the dissolved nutrients in that water, however, much more slowly than they do the water. A closed system like the My Garden™ may need make up water daily while a batch of nutrients may last for 2 weeks.

This is true however only in a truly closed system. If there's a leak, even a very small one, the nutrients are being lost right along with the leaking water. Instead of the nutrients lasting for 1 - 2 weeks the plants will begin to show nutrient deficiencies and grow poorly.

If you have a leak it may be where a GroPipe attaches to the manifold. Tighten the connection. If leaking continues wrap Teflon tape (included with Starters and Spares) around the Manifold Port threads. Leaking can also occur inside the Reservoir which does no harm except reducing flow pressures. The Pump and Filter assembly is not glued so simply push the components firmly together.

Appendix B: Transpiration and plant nutrition

Seeds require only water for germination because they carry their own stored food. After germination, the nutrient packets provide the precise concentration of the 13 plant essential nutrients in the same proportion that field-grown plants take them from the soil solution (nutrients from rocks and minerals dissolved in rainwater). Plants are tolerant of nutrient solution concentration to a point but growth and development will suffer if the solution becomes either too concentrated or too dilute.

Under good growing conditions plants take up the water in large quantities and pass it out through pores in their leaves for cooling a process called transpiration. But they take up the 13 nutrients separately and individually and at much slower rates than they do the water. This is insignificant with small seedlings but a large crop canopy in the Garden on a hot sunny day will transpire up to 2 gallons of water to cool themselves while removing relatively few nutrients. That water must be replaced regularly or the nutrient solution becomes too salt concentrated and will damage the plants (not to mention that the plants will wilt and die once they've used up all the water). The plants do take up the nutrients too of course, albeit at a much smaller rate than water which is why the nutrient solution should be changed out periodically.

Note: Hot sunny days are a challenge outdoors including in full-sun balconies. Indoors, under cool LED lamps, transpiration rates are low and water loss is minimal. Nevertheless check and correct (with water only) periodically.

Appendix C: Water pH – a measure of soil acidity

Nutrient solution (or in the field, soil) acidity (measured in pH units) influences the uptake of nutrients by plants. When the pH is too high or too low plants have difficulty taking up nutrients and exhibit stunted growth, yellowing and other nutrient deficiency symptoms. You may have noticed in your landscape that acid loving plants like pin oaks, blueberries, and azaleas turn yellow in alkaline soils. That's because they can't take up iron at a high soil pH. Fortunately, plants are quite tolerant and likely OK if deficiency symptoms aren't visible. Water chemistry varies tremendously from region to region so some experimentation required.

In Central Florida city water is pumped from a calcium carbonate aquifer making it an alkaline pH 7. Adding ½-1 cup of white vinegar to 4 gallons of nutrient solution drops the pH to a much better (for most food crops) 5.5. When plants are small they can be kept at 5.5 with vinegar additions but once they're large and transpiring lots of water maintaining a lower pH is a difficult to impossible proposition. Despite that we have successfully grown many vegetables and herbs in the Garden even at pH 7. In your location, if you're lucky, you'll find your water's pH is the ideal 5.5!

Note: Measuring pH requires a pH meter or indicator paper. A pH range close to 5.5 on the meter or paper color chart will be ideal for most crops. Adding vinegar lowers higher pH readings. If your pH is higher than 7 (the indicator paper turns green) ½ cup of white vinegar for every 4 gallons of nutrient solution should drop the pH to 5.5. Add vinegar again each time the pH drifts high. Good luck!

Appendix D: Hydroponics Primer

In hydroponics the objective is to maintain the plant tissue concentration of each of 13 root-absorbed essential elements between their critical and toxic limits. This "adequate" concentration zone can be wide for the macronutrients (those required in "large" amounts) and quite narrow for many of the micronutrients (those required in "tiny" amounts). However, even with macronutrients, it's important to avoid "luxury consumption" or the upper end of the adequate zone, to reduce both fertilizer costs and environmental pollution.

Plants get their oxygen(O), hydrogen(H), and carbon(C) from the air (elements in the middle of the table below). Interestingly, even though air is 80% nitrogen, they can't get their nitrogen, a macronutrient, from air except in rare cases in the pea family including soybeans where bacteria growing in the plants roots can fix aerial nitrogen. Plants take up nitrogen and all other nutrients except O, H, and C from the soil solution which is dissolved rocks and minerals in rainwater. Rocks and minerals have very complex chemical structures that include all the elements listed in the table below.



Essential elements for higher plants

<u>Element</u>	<u>Chemical Symbol</u>	<u>Form Available to Plants*</u>
Sulfur	S	SO_4^{2-}
Phosphorus	P	H_2PO_4^- , HPO_4^{2-}
Magnesium	Mg	Mg^{2+}
Calcium	Ca	Ca^{2+}
Potassium	K	K^+
Nitrogen	N	NO_3^- , NH_4^+
Oxygen	O	O_2 , H_2O
Hydrogen	H	H_2O
Carbon	C	CO_2
Molybdenum	Mo	MoO_4^{2-}
Copper	Cu	Cu^+ , Cu^{2+}
Zinc	Zn	Zn^{2+}
Manganese	Mn	Mn^{2+}
Iron	Fe	Fe^{3+} , Fe^{2+}
Boron	B	H_3BO_3
Chlorine	Cl	Cl^-

In hydroponics rocks and minerals are broken down through weathering into simpler components (what we call nutrients) which dissolve in water more easily than their original complex structures. We are exactly mirroring what occurs in the natural environment.