

## Small Hydroponic Grow Tower System

### Directions

The 'Do It Yourself' (DIY) Grow Tower Project is the brainchild of Alaskan entrepreneur Bernie Karl and his former greenhouse manager Jake Scott. It is much more than just an experiment with vertical hydroponics, it is a concept meant to spark the curiosity of the youth all over the country - To help sow the seeds that will yield the next generation of farmers and food suppliers in America.

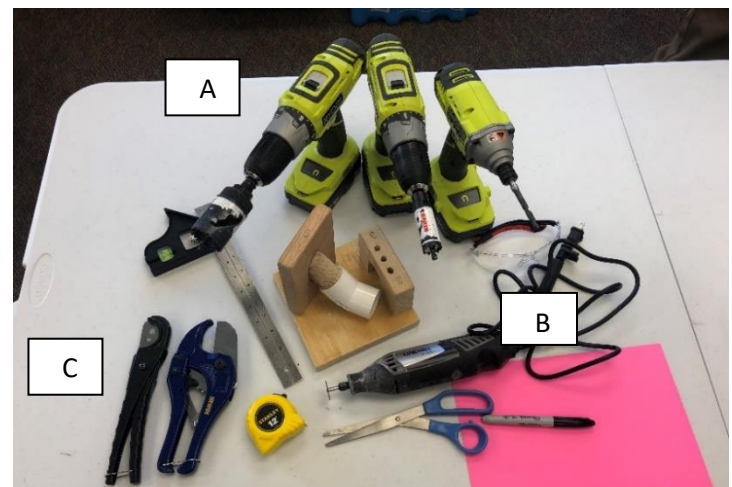
In order to cultivate a genuine passion for food production, one must first be introduced to it in a hands-on manner. That is the true purpose of the Lettuce Tower Project - An easy-to-build project that can get anyone involved in the construction and use of a hydroponic food production system.



The original system was a larger bucket tower that used 5-gallon buckets for the tower and a sump basin as the bottom. This smaller version using a 5 gallon bucket and three 2 gallon buckets was designed by the Upward Bound Program at the University of Alaska Fairbanks and further modified by the Silent Springs FFA chapter.

### Tools Needed:

- Drill (preferably cordless) (A)
- 1-5/8" Hole Saw Drill Bit
- Sharpie Marker
- Dremel Tool and Cutting Blades (B)
- PVC cutting tool (C)
- 7/8" Hole Saw Drill Bit
- Copies of the Stencils (end of directions)
- 1/4" Drill Bit
- Heavy Duty Scissors
- Ruler/Tape Measure
- **Protective Safety Eyewear for all!**



### Materials Needed:

- Three 2-Gallon Buckets
- One 5-Gallon Bucket
- One 5 Gallon Bucket Easy-Off Lid\*
- Three 2-Gallon Bucket Easy-Off Lids\*
- Four Foot length of 1/2" PVC straight PEX tubing
- Sixteen 1" 45° PVC Elbows
- 158-200 GPH Submersible Water Pump
- 1/2" PVC Male Adapter
- Six 1/4" x 1" Stainless Steel Hex Bolts
- Six 1/4" Stainless Steel Wing Nuts and washers
- Four 2 Ft. LED Light Fixture
- Hot Glue Gun and extra glue sticks
- Plumber's Silicone (optional or possibly necessary)
- Scrap piece of wood to drill on so you don't ruin your table or floor.

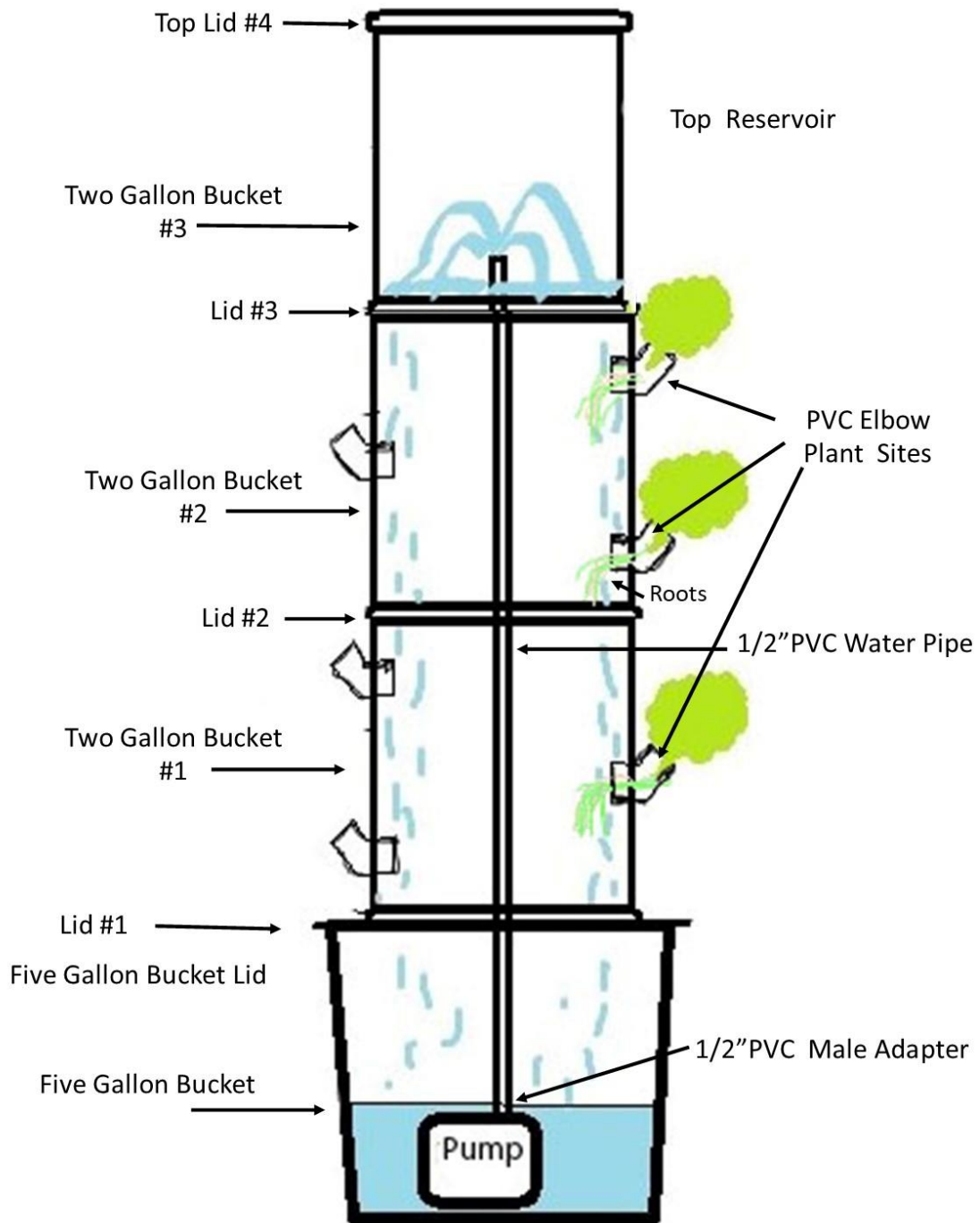
\* There are different types of bucket lids. Be sure to get the sturdiest lids you can find. It needs to hold the weight of the plants and the buckets.

### Materials for Light Supporting Structure:

- 1" PVC Pipe – 4 4' lengths and Eight 21 1/2" lengths
- Eight 1" 90° PVC Three Way Elbow Sockets
- 2 2'x2' pieces of plywood for top and bottom (Optional)
- Zip Ties or Small Screws for attaching the lights
- One 6 spot surge protector power strip
- Three Prong Outlet Timer



# Tower Diagram



## Prepare the Buckets and the Plant Sites

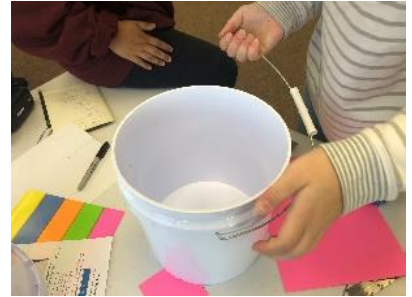
Step 1:

Remove the handles from all buckets.

Step 2:

Number the 2 gallon buckets with the numbers 1-3 with a sharpie on the bottom.

\*\*\*\*Set aside #3...Don't mark up this one! It is the top bucket and doesn't get holes drilled in it.\*\*\*\*



Step 3:

Mark the 2 gallon buckets for drilling using the Stencil A (found at the end of these instructions) These holes will be for the plant sites.

- Poke a hole in the template at the sites A, B and C with a pencil.
- Fold up the dotted line on the template and lay the template flush with the lid of the top of the bucket and mark the three holes through the stencil with the sharpie.
- Move the stencil over to match up hole A on the stencil to the spot you marked for hole C and repeat the marking until you have 8 spots marked on the bucket.
- Repeat the marking for the second bucket. (Remember the 3<sup>rd</sup> bucket should not be marked)



Step 1:

Prepare the drill with the 1 5/8" Hole

Saw.

## Drill the Plant Sites



**Step 2:** Cut out the plant sites on the 2 buckets using the 1-5/8" hole saw.



The plastic circle cut out will likely get caught in the drill bit. Use a screwdriver or pliers to remove it if needed.

## Drilling and Installing the Elbows

***Be sure to wear safety eyewear for all Power Tool steps, anyone nearby should wear safety eyewear also.***

**Step 1:** Use the 1/4" Hole Saw Drill Bit and a vise to hold the elbow or use a jig like the one below for drilling the holes. Drill three holes into the top of each PVC elbow to allow water to reach the plant roots. Be sure to drill the 3 holes in the top of each PVC elbow as pictured below. Uniform placement of holes is not necessary as long as they are in a location that water falling from the top of the tower can drip through and they are not right up to the bend in the elbow. The holes should be positioned so that they are completely inside the bucket when the elbow is inserted. *Clear away any plastic debris.*



**Step 2:** Insert each elbow into each of the holes on buckets #1 and #2 . *It will be a tight fit so be forceful.*



## Gluing the Elbows

- Step 1:** Now it's time to seal the elbows. Plug in the glue gun and have plenty of extra glue sticks handy.
- Step 2:** Using the glue gun, create a seal around each elbow to the bucket. Be sure to create an even seal around bottom and sides of the elbows. Be sure there is proper ventilation for fumes. Remove any hairy glue strings left after you finish.



## Prepare the Bottoms of the 2 Gallon Buckets

*Be sure to wear safety eyewear for all Power Tool steps, anyone nearby should wear safety eyewear also.*

**Step 1:** Prepare the Dremel Tools with a cutting blade.



**Step 2:** Mark the bottom of the 2 gallon buckets using the Stencil B (found at the end of the instructions). Look for the circles in the center of the bucket bottoms. Flatten any dimples in the plastic in the middle of the circle using the Dremel tool.

**Step 3:** Look for the circles in the center of the bucket bottoms. Flatten any dimples in the plastic in the middle of the circle using the Dremel tool.



**Step 4:** Put the 7/8" Drill Bit on the Drill and drill a hole in the center of the bucket bottom. The plastic circle cut out will get caught in the drill bit. Use a screwdriver or pliers to remove this happens.





**Step 5:** Using the Dremel, cut away two large sections leaving just a strip of plastic where the water line and bolt holes are situated.



**Repeat Steps 3-5 for all the 2-gallon buckets including the top one which doesn't have plant sites.**

## Prepare the Lids of the 2 Gallon Buckets

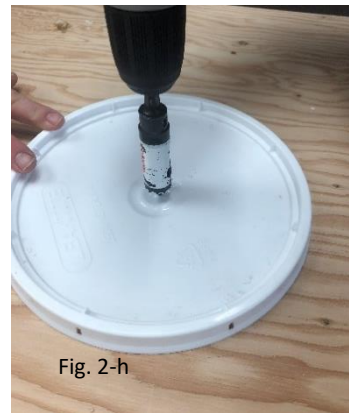
*Be sure to wear safety eyewear for all Power Tool steps, anyone nearby should wear safety eyewear also.*

### 2 Gallon Lids

**Step 1:** Set one 2 gallon lid aside, this is the top lid and will not have holes.

**Step 2:** Mark two of the 2-gallon bucket lids using Stencil C.

**Step 3:** Prepare the drill with 7/8" hole saw. Using the drill and the 7/8" hole saw, cut a hole for the water line in the center of the 2 bucket lids. Repeat for the second lid.



**Step 4:** Remove the hole saw and put the 1/4" drill bit on the drill. Create the drainage holes the bucket lids using the 1/4" drill bit. Do this for both of the lids.



- Step 5:** Lay the lid on top of the bottom of the bucket. Use the sharpie to mark the hex bolt spot on the bottom of the bucket through the lid. Drill the two symmetrical holes on the bottom of the bucket. Make sure the holes line up. Connect the two with hex bolts, wing nuts or regular nuts and washers (if desired).
- Step 6:** Connect the two with hex bolts, wing nuts or regular nuts (and washers if desired).



## Prepare the Lid of the 5 Gallon Bucket

*Be sure to wear safety eyewear for all Power Tool steps, anyone nearby should wear safety eyewear also.*

**Step 1:** Cut the center hole out of Stencil C and place in the center of the 5-gallon lid and use a sharpie to mark the circumference and the center hole.

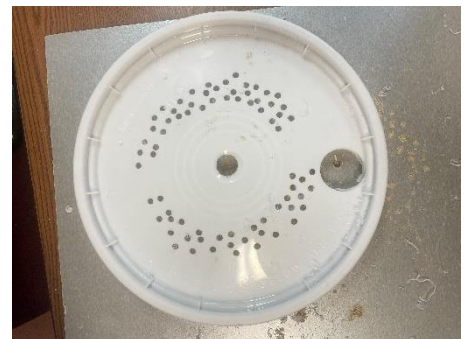
**Step2:** Using the ¼ inch drill bit, Drill drainage holes in the 5-gallon lid through the paper of the stencil. *Be sure to drill on a piece of wood so you don't damage the table you're working on.*



**Step 4:** Using the 7/8" hole saw, drill the center hole through both the lid and the 2 gallon bucket bottom.



**Step 5:** Use the 1 5/8" hole saw to cut a hole in the 5-gallon lid for the electric cord for the pump. Make sure this hole is not in line with the center hole.



**Step 6:** Lay the bucket lid on top of the bottom of the 2-gallon bucket (*one with plant sites*). Drill two holes through the lid and bottom of the 2-gallon bucket to have these holes line up perfectly. Clear away all plastic debris.

**Step 7:** Bolt the lid to the bottom the 2-gallon bucket.



## Set up the Water Line and Assemble the Tower

- Step 1:** Connect the threaded male PVC adapter that comes with the pump to one end of the 4ft length of ½" PVC pipe. Attach the hose fitting to the PVC ½" adapter, push hard and it will fit in there.



- Step 2:** Screw the adapter and PVC Pipe into the pump and place the pump in the bottom of the 5 gallon bucket.

- Step 3:** Slide the tower bottom lid and bucket assembly down the pipe and feed the pump cord through the hole you drilled for it.



- Step 4:** Slide the rest of your buckets in the order that they are numbered and firmly snap each lid to the top of the next bucket. Add a funnel to the top bucket on the pipe to help distribute the water evenly to the sides. Trim pipe with the PVC cutter to be flush with the top of the funnel. Put on the top bucket lid.



## Building the Light Structure

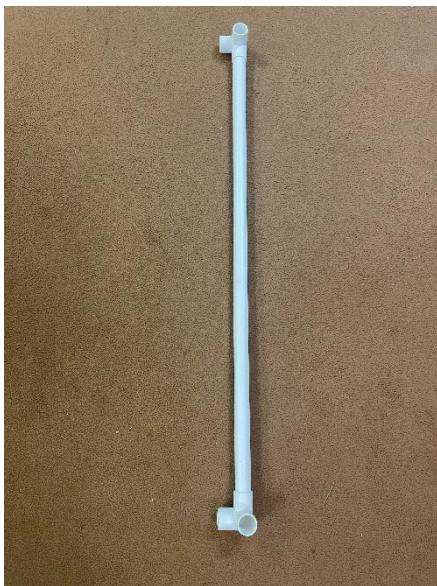
**Step 1:** Cut four 4 foot lengths of 1" PVC pipe using the PVC cutter.

**Step 2:** Cut eight 2 foot lengths of 1" PVC pipe

**Step 3:** Count out 8 three way PVC elbows.



**Step 4:** Attach 2 elbows to each of the four foot PVC Pipes.



**Step 5: Add a 2 ft pipe to one of the 4ft pipes. Connect to another 4 foot pipe.**



**Step 6: Continue connecting all the pipes until your structure looks like this:**



**Step 7: Attach the lights to the 4 foot pipes with zip ties and the light holders that come with the lights. You can also screw them directly into the PVC with the screws that come with the lights.**





## Growing Plants in Your Tower

**So you have built a brand new vertical grow tower...**  
***Now what?***

**Crop Selection:** The first choice to make is which crop you will grow in your tower as this will determine what type of fertilizer and potential lighting needed to get results. The Bucket Grow Tower was originally created with the intention of growing lettuce and this choice may be the easiest for beginners, but the possibilities are much greater. The tower can produce spinach, arugula, mustard greens, strawberries, several herbs and many other options.



**Fertilizer Selection:** The fertilizer chosen should cater to the preference of the crop chosen. We recommend using a hydroponic fertilizer. Some fertilizer brands such as DynaGrow has proved itself to work well in the tower. If you can't find a fertilizer specifically designed for your crop just take to the internet to find out what levels of N-P-K in a fertilizer are right for your plant and find a general use N-P-K fertilizer at your local home & garden store that is close to the levels your plant desires. **No matter what fertilizer product you choose, remember to always follow the mixing instructions on the package for best results.**

**Light:** You WILL need lighting to get the results you want. Just placing the tower in a window is not enough for plants to grow well. If you choose to grow lettuce or other leafy greens in your tower, your lighting requirements will be minimal and can be satisfied by using inexpensive LED light tubes and fixtures available at any home improvement store. If you decide to tackle a bigger challenge and produce a flowering/fruited crop in your tower, then you may need to invest in some horticultural grade grow lights to achieve the best results. Always research your crop beforehand so you understand what kind of lights your plants need.

## Starting Your Seedlings

**Choose Your Grow Media:** The grow tower requires plants to be grown in an inert media that provides support for the stem and roots but gives no nutrients to the plants. Soil does not work because it will wash away and clog the pump. The two types of media that work best in the tower are Rockwool (1 ½" cubes) or Rapid Rooter peat plugs. Both come with a hole in the top for placing your seeds. It is best to wash the rock wool and the rooters before using.

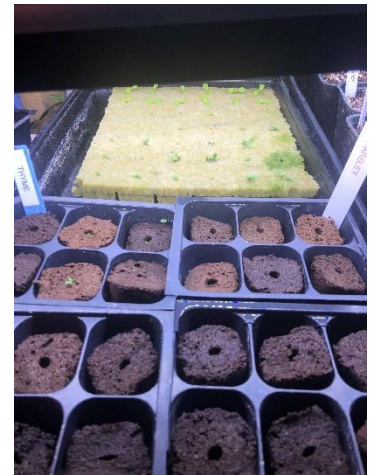


### Starting Seedlings:



Start your seeds in six pack containers and have them under lights on a shelf for 2-3 weeks before you intend to put them into your grow tower. It is a good idea to start more seedlings than will actually fit into your tower so you may pick the strongest most promising seedlings to transplant into the tower.

Place one to two seeds in each cube or plug. Plants should be grown on a shelf with lights at most 3" from the container they are grown in. If you don't have a shelf, grow the plants on a plate on the top of the tower.



### Watering the Seedlings:

From planting the seed until transplanting into your tower, you may just water the media and seeds with regular, unfertilized water. Spray bottles are the best to assure you don't over water. The cubes should be watered daily and kept consistently moist throughout the germination process.

### Are they ready?

About a week after your seedlings emerge begin checking the bottoms of the cubes daily. Once you can see little white roots starting to poke out of the bottom of the cubes or plugs and your second set of leaves have emerged, your seedlings are ready to go into your tower.

## Putting the Plants into the Tower

### Prepare your tower:

Mix the fertilizer of your choice according to the instructions on the fertilizer label and fill the base/reservoir of the tower with 3-4 gallons of this nutrient solution. Do NOT over fertilize, read the directions on the bottle.

If you are using Dyna Grow Fertilizer:

1. When you add water to the tower initially, add 2-3 tsp of fertilizer per gallon.
2. When you add water as the tower is going, reduce it to 1 tsp/gallon
3. If you have too much algae in the water and it gets very green, replace all the water and treat it as you would as if you were starting the tower again.



### Add the Plants:

If using rockwool, break your rockwool cube sheet into individual cubes with one plant per cube. Nestle the plant cube or plug into a PVC elbow and gently push it down into the elbow so that it is securely nestled in the elbow underneath the three holes that you drilled. Be sure not to push them too far and lose them inside the tower.

### Lights:

Keep the lights on a timer. 12 hours on and 12 hours off is the best schedule for leafy plants. Do not plug the pump into the timer. The pump should be on all the time and plugged in separately.

### Harvesting Your Plants:

Plants do not need to be harvested all at once. You can use the leaves as they grow. Pick lettuce leaves from the outside to encourage continuing growth. Do not pick from the middle of lettuce. Herbs should be picked so that you don't remove all the leaves. The plants will sprout new leaves. Always remove any flowers on herbs.



## Monitoring and Cleaning Instructions

1. Monitor water levels and replace water, add nutrients to water before adding according to directions on container, as necessary. READ the directions, don't over fertilize!!!! It's a good idea to reduce the fertilizer on water additions after the initial starting of the system to prevent nutrient buildup and overload.
2. Recheck pH and adjust with proper solutions if necessary. Watch leaves for any browning or yellowing. This will let you know if you have enough or too much nutrient in your water.
3. Check the pump. Unscrew the PVC center pipe from the pump. Pull off the half of the pump that has the sponge looking black filter material on it. It should come off with a little tugging. There is a foam filter in there, wash out the plant material and put the pump back together and put back on the PVC pipe and back into the tower.
4. Visit <https://www.youtube.com/watch?v=Webb1cjen6s> or <https://www.nosoilsolutions.com/common-issues-hydroponic-gardeners-face/> for suggestions on troubleshooting growing issues.

Nutrient Suggestions: Choose a liquid hydroponic nutrient based on your preference, organic or not. If you are just doing leafy greens, choose a nutrient specific to growing leaves often labeled "grow". If you are doing a plant with fruit, you will need to change the nutrient once the plant reaches a certain maturity (different with each type), often labeled "bloom", when you wish for them to begin the process of developing fruit. You will need to hand pollinate the plants.



PH Testing – Use a test kit. A liquid test kit is preferable, but strips work as well. Use a solution to raise or lower the pH depending on results. Over fertilizing is often the cause of a wacky pH, but it can be the water you start with as well.

### Algae and Pests

Algae growth is normal in a grow tower. It is not toxic or dangerous to the edibility of your plants. Fungus gnats which love algae can be a problem. Here is an article that might help you if you have an algae issue.

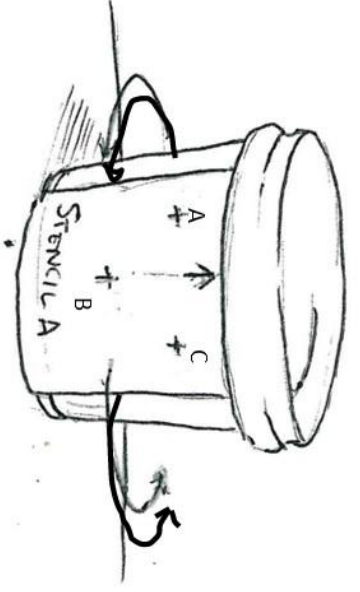
<https://plantprovider.com/managing-algae-in-hydroponic-systems-step-by-step/>

Aphids can get on a tower when you introduce houseplants bought at a store or nursery. Use non-toxic sprays to manage like NEEM oil or Safer Insect Soap spray.



A

+



C

+

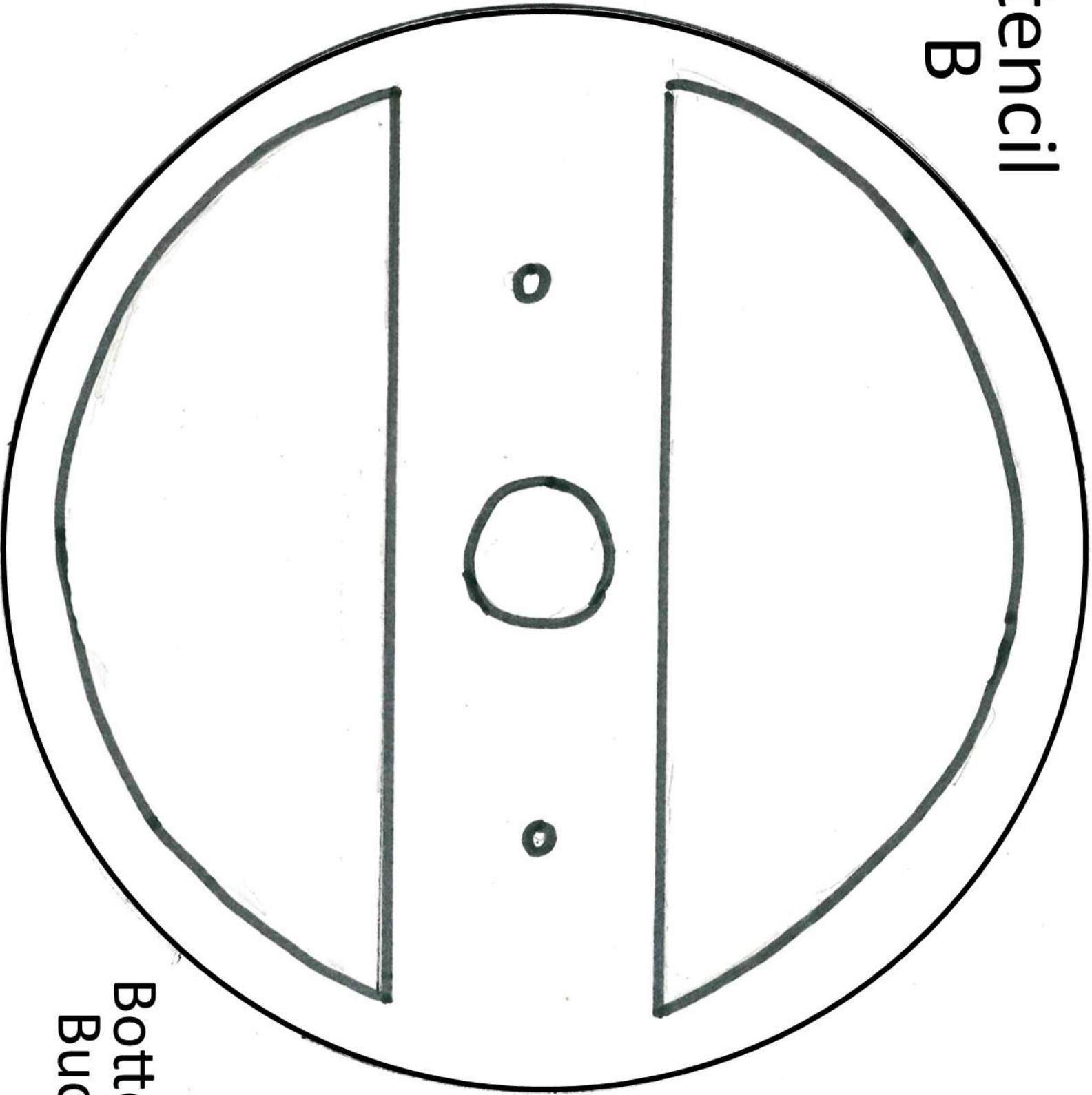
Stencil A

+

B

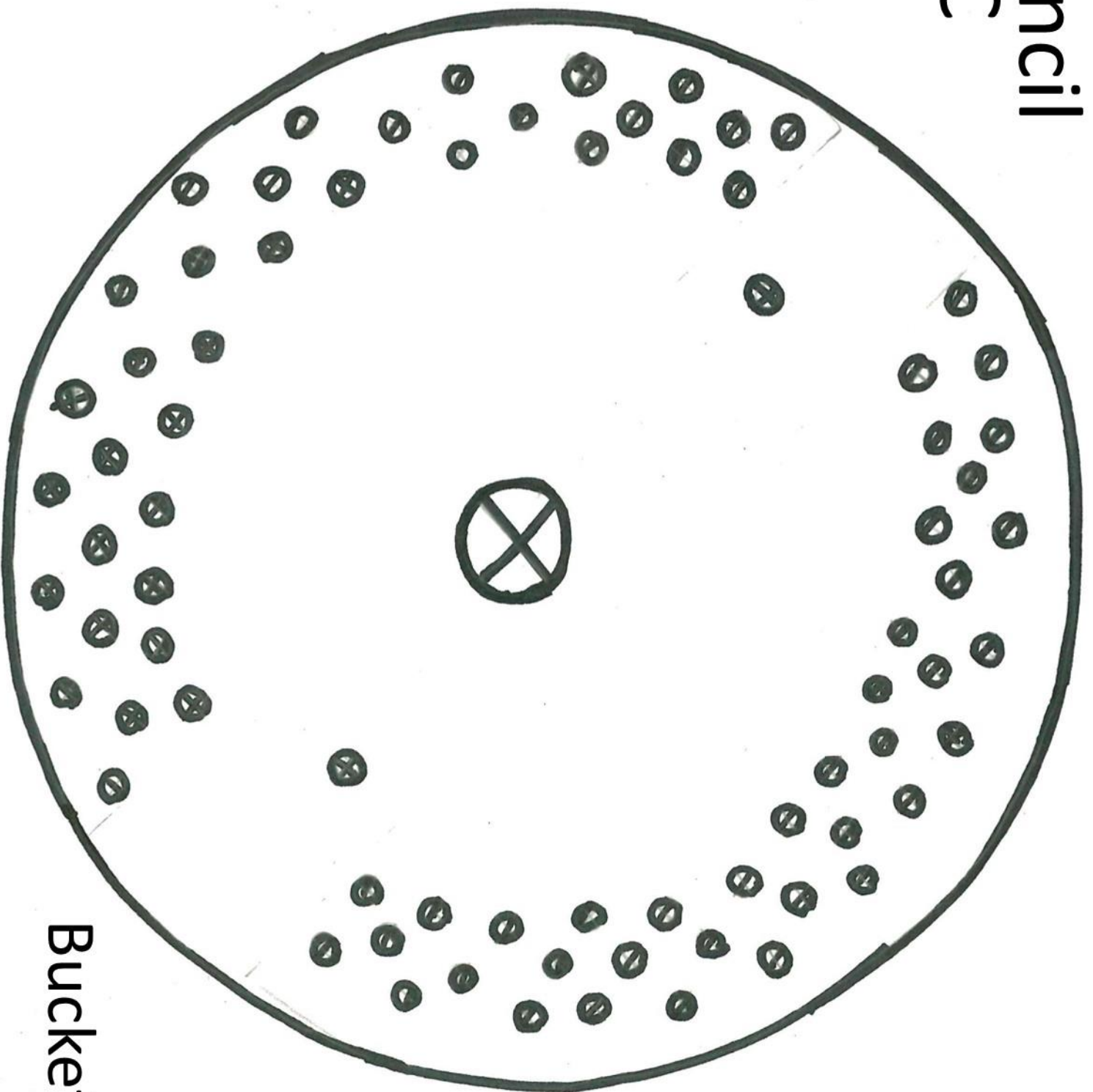
Bottom Fold on Dotted Line

# Stencil B



Bottom of  
Bucket

Stencil  
C



Bucket Lid