

Self-Watering Wicking Container

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A wicking container is a self-contained method for growing vegetables, fruits, herbs, and flowers. This container provides a built-in water reservoir that allows a plant to self-irrigate. The design is ideal for individuals who are new to gardening or have limited space but is also used by seasoned gardeners. The greatest benefit of the system is that it provides the plant with control of its water supply, which helps free up more of the gardener's time.

The Science behind Wicking Containers

The reason wicking containers work so well is because plants are watered from the bottom up through the process of capillary action. Capillary water is soil moisture that is held in the gaps and voids of the soil by surface tension. Capillary action or capillarity is the rise of liquid created by increasing surface tension, which allows water to defeat gravity and move up. The smaller the particle, the greater the ability to defeat gravity. So even though the water table may be at the level of the drain hole, capillary action will move water up approximately 4 inches above this, creating an ideal environment for roots to obtain water for the plant. Plants will increase surface tension as they draw water through their roots. This creates the condition where the plant is hydraulically and continuously connected to the groundwater table, which provides the greatest benefit. During the growing season, mature plants will naturally obtain water through rainfall events, by capillary action or after the roots reach the water table. Overwatering, underwatering, or forgetting to water is buffered by the ability of plants to self-regulate their water requirement. This phenomenon makes this wicking container design ideally suited for individuals new to gardening.



Advantages

The advantages of a wicking container are:

- It is a self-contained system for growing plants.
- The raised level of the container makes maintenance and harvesting easier.
- The scale and design make them ideally suited for individuals with limited space.
- Since wicking containers water from the bottom up, the surface soil is drier, which reduces weed competition.
- Watering from the bottom up promotes water efficiency by reducing evaporation from the surface of the soil and runoff.
- The water reservoir (Figure 1) captures water from rainfall events and reduces runoff and loss of nutrients.
- The plants are self-watering! They are never deprived of water because it is always available in the reservoir.

- Gardeners with limited time can use large capacity reservoirs to extend watering events.
- Overwatering of plants is controlled by the level of the drain hole.
- Container gardens can be started earlier in spring than traditional garden beds because they are not insulated by the earth. Conversely, in winter, containers will freeze sooner than earthen beds for the same reason.

Disadvantages

The disadvantages of wicking containers are:

- They are more expensive to create than traditional gardens or beds.
- Containers may freeze sooner in the fall than non-raised beds since the plant(s) is not in the ground.
- Because each pot has limited soil and nutrient holding capacity, planting multiple plants in one pot may require more frequent fertilization and watering.

Construction

There are many ways to construct a wicking container. The following model is just one method using the wicking concepts. The container chosen for this publication is a muck tub, which can be purchased from a big box store, garden center, or farm supply store. If available, an empty mineral tub, an item commonly discarded by dairy and beef cattle producers, can be substituted to reduce project cost.

Other materials needed:

- Perforated pipe of 4 inches to create the water reservoir (false bottom).
- PVC pipe of 1.5 or 2 inches as a fill tube (approximate length, 16 inches).
- Peat moss to create the wicking material.
- Compost and potting soil to create the soil matrix.
- Filter fabric/landscape fabric.
- Gravel (will increase the weight and cost).

Tools needed:

- Utility knife
- Drill and drill bits
- Hole saw (possibly)
- Hacksaw
- Scissors

Fabrication

Step 1. Creating the Fill Tube

The fill tube is used to fill the water reservoir (Figure 1). The fill tube should extend 2 inches above the top of the tub or higher, approximately 18 inches. Measure this distance and cut a piece of pipe (1.5- or 2-inch diameter PVC preferred). Cut the fill tube pipe at an angle of approximately 30 degrees or more and place the end in the perforated pipe to allow added water to freely flow into the reservoir (Figure 2).

Step 2. Creating the Water Reservoir

An area for the water reservoir—the volume of water below the drain hole (Figure 1)—must be created in the bottom of the tub. To create the reservoir, cut a piece of perforated pipe and fashion it in the shape of a ring. Keep in mind that a typical muck tub is approximately 16 inches deep and wide.

The perforated pipe ring can be created in one of two ways, depending on skill level: overlapping and butting (Figures 3 and 4, respectively). The overlapping version (Figure 2) requires that a hole be made to insert the fill tube. Make the hole using a razor knife or by drilling a hole with a hole saw, preferably after the pipe has been placed in the bottom of the tub.

The hole can also be fashioned by cutting an X across in the top surface of the pipe with a razor knife and pushing the fill tube through the opening.

Alternatively, the butting method (Figure 4) requires using a hole saw to drill a hole that exceeds the outside diameter of the fill tube/pipe. The butt version requires a section of perforated pipe approximately 44 inches in length. Butting the ends creates a triangular void for installing the fill tube. This method has the advantage of eliminating several steps associated with creating the opening for the fill tube. However, filter/landscape fabric or an equivalent material will need to be used to seal the connection (Figure 5).

The approximate length of pipe needed can be determined by measuring the inside diameter of the tub (in this case 16 $\frac{1}{4}$ inches). Measure the outside diameter of the perforated pipe (in this case 4 $\frac{1}{2}$ inches). Calculate the adjusted circumference by subtracting the radius of the perforated pipe, in this case 2.3 inches, from the tub diameter. Plug this value into the equation (Equation 1) to determine the approximate length of perforated pipe needed, in inches, to create a ring. Add 6 inches to the adjusted circumference length for the overlapping version. Dry fit the pipe in the tub to check dimensions and fit.

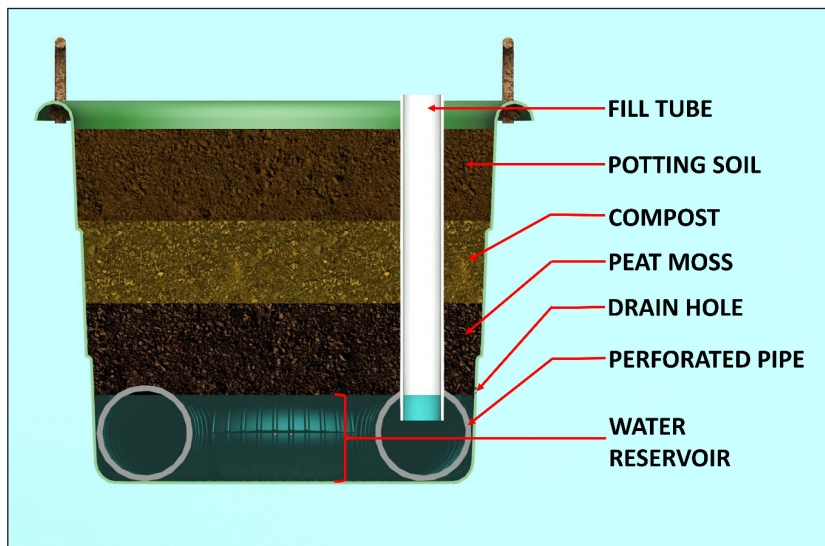


Figure 1. Wicking container garden. James Ash



Figure 2. Fill tube cut to length with a 30-degree angle cut on one end.

Equation 1. $C = \pi D$

Inside diameter of tub: 16.25 inches

Outside diameter of pipe: 4.6 inches

$$D = 16.25 - (4.6/2) = 13.95$$

$$C = \pi \times 13.95$$

$$C = 43.8$$

Example:

$$\text{Circumference} = 43.8 \text{ inches} = 3.14 * (16.25 - 2.3)$$

Step 3. Creating the Inner Reservoir

The inner circle void (the area inside the perforated ring) should also be displaced. One way is to cut an approximately 6-inch length of perforated pipe, wrap it in filter fabric or landscape fabric to block off the ends, and place the section in the inner circle (Figure 6). The same fabric piece can be used to close any voids around the fill tube. The two semi-circular voids created in the center will create water columns and the area needed to create capillary rise.



Figure 3. Perforated pipe overlapping itself. Fill tube hole installed using a hole saw.



Figure 4. Butting the ends of the perforated pipe creates a void for installing the fill tube.



Figure 5. Filter/landscape fabric is placed in the void to prevent soil from entering the cut ends of the perforated pipe.

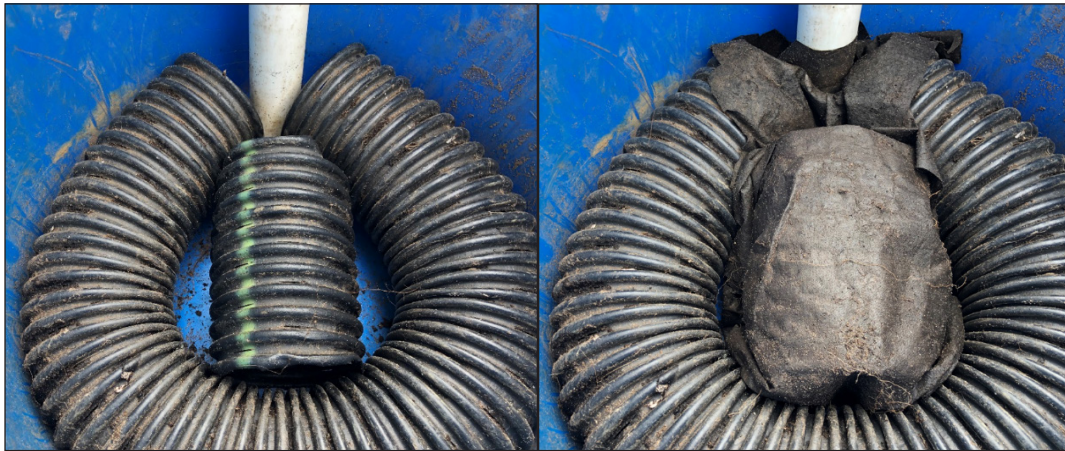


Figure 6. Creating water volume by displacing soil.

Step 4. Creating the Drain

The water volume reservoir should not be higher than the perforated pipe that creates the false bottom. In this case, the pipe is 4.625 inches in diameter with a wall thickness of .5 inches. Drill a hole approximately 4 inches from the inside bottom of the tub or just below the height of the pipe. (Figure 7). The hole size should be approximately 5/16 to 3/8 inch in diameter to allow any overflow water to freely exit.

Water volume is determined using the equation for the volume of a cylinder (Equation 2). Note: *Be aware of units and conversions.*

A tub of this size can have a reservoir capacity of approximately 3.4 gallons. However, more water will be required to wet the soil. To create this volume, a reservoir will be fashioned using the perforated pipe. The pipe should create a loop when placed in the bottom of the tub.

Variation: Some designers of wicking containers recommend using rock in place of the perforated pipe. This method adds significant weight to the wicking container, at approximately 110 pounds per cubic foot, and provides approximately 30 percent void space. Using 4-inch perforated pipe increases the volume of water that the reservoir can store by approximately 100%. It is also an easy, light, and cheap way of supporting the soil above the reservoir.

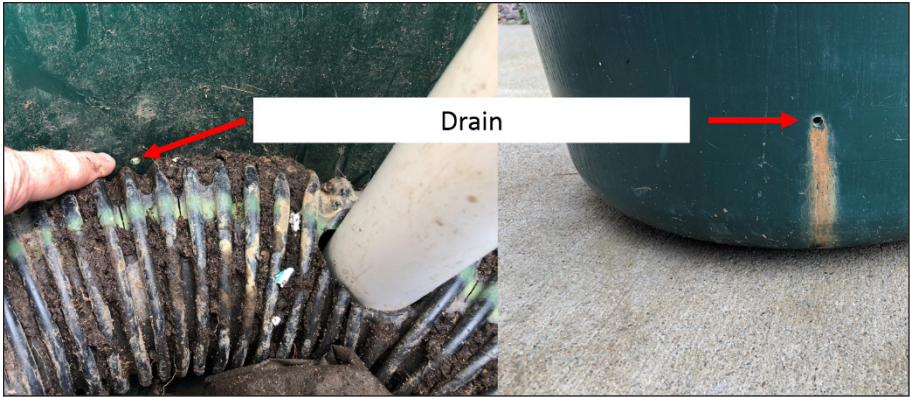


Figure 7. Drain hole location (inside and outside, respectively).

Equation 2. $V = \pi r^2 h$

Example:
 Volume of a cylinder = 0.45 cubic feet = $3.14 * (0.66 \text{ feet})^2 * 0.33 \text{ feet}$

Conversion:
 Cubic feet to gallons
 = 0.45 cubic feet * 7.48 gallons per cubic foot = 3.4 gallons

The design of the container will be affected by the type of plants chosen by the gardener. A light biomass load may require watering once every week to 10 days, whereas heavy to moderate loads may exhaust the water supply after three to five days. The design can be modified to add a second perforated ring and with the drain hole located appropriately

to increase the volume of water in the reservoir (Figure 8), which will provide higher moisture levels to the upper soil profile. This method may be particularly beneficial for shallow rooted and water loving plants, which may survive with a minimum amount of soil and require a significant volume of water.

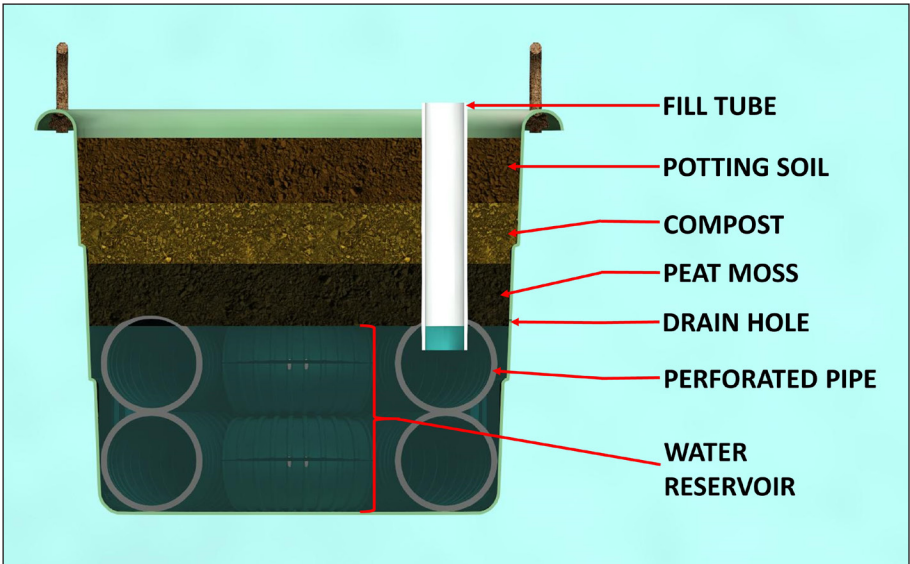


Figure 8. Wicking container design with a large water reservoir. James Ash

Step 5. Filling the Tub

Once all the components are assembled, the tub is ready for adding the soil matrix. Soil texture is very important for wicking containers. For a wicking container to function properly, a layering of specific soil types (avoid anything too heavy, such as clay) is recommended to wick water to the surface. A layer of peat moss will act like a sponge to wick water to the soil. It should be placed to a depth of approximately 4 inches from the top of the pipe. The next layer is 3 to 4 inches of compost, followed by approximately 3 to 4 inches of a good quality potting soil (Figure 1).

All soils should be moist when placed to provide the proper soil structure and to limit dust. Wetting the soil can be accomplished by dribbling or spraying water in a bucket of soil and blending to create a damp soil matrix. A damp soil will subside less and obtain optimum growing conditions sooner than dry placed soil.

Operation and Maintenance

Watering the container is accomplished by placing water in the fill tube. When the reservoir is full, water will flow out of the drain hole. Gardeners may want to avoid overfilling when rainfall events are imminent or leave space when filling for eminent rainfall events to supplement without creating a flush, which can lessen fertility. Water used for filling the reser-



Figure 9. Homemade water level gauge.

voir can be obtained from rain barrels, another productive gardening project. See *Building a Rain Barrel* (HENV-201).

Since the bulk of watering will be from the bottom, the occurrence and need to remove weeds is almost negligible. When it is needed, it is easy to accomplish.

During the growing season, plants will need adequate nutrition. General information regarding fertilizing can be found in the publication *Home Vegetable Production in Kentucky* (ID-128).

Off-Season Maintenance

Plants in wicking containers like this are more exposed to the elements, and the container does not have the thermal properties to prevent freezing. At the end of the growing season, the reservoir can be drained by tipping it over and allowing water to exit the drain tube. Draining is definitely required in zones where a hard freeze is predicted. An open container can also be leaned to one side or chocked up with a brick or wood block on one side to change the geometry, which would allow expanding ice room to increase without breaking the container. Another option is to move the container indoors in winter to store it or to continue growing plants. A cover for the container fashioned using a plastic bag or sheet will prevent precipitation events from adding water while limiting weed infestation during the off season.

Some advise not using the same soil matrix for annual plants. Using the same soil year after year may be managed by rotating plant species with the seasons. Rotation can be a preventative way of reducing plant diseases and pests; providing adequate fertility, pH, and soil health can also reduce plant stress and diseases.



Devices that can be added to improve operation and performance include:

- Tomato cages to support plants. The rigid plastic nature of the container means that it will not be harmed.
- A mini cold-frame cover can be fabricated and placed over the container to extend the growing season.
- Water level indicator. A water level indicator can be created by fashioning a flotation device, which can be used as a water level gauge. Once placed in the fill tube, the gauge can be used as a quick reference for the gardener. The gauge shown in Figure 9 was fashioned from a cork and a bamboo skewer. A small hole was drilled to insert the skewer and a bead of hot melt glue was used to secure the two. The twist tie indicates the level when the reservoir is full.
- An open fill tube may attract mosquitoes. A simple solution is to create a cap that can be removed when filling the reservoir.

Summary

A wicking container is a self-contained method for growing vegetables, fruits, herbs, and flowers. It is an effective and efficient piece of garden infrastructure that any gardener can enjoy. A built-in water reservoir allows plants to self-irrigate. This design uses accessible hardware and basic skills to create a wicking container. The scalable design is ideally suited for individuals who are new to gardening or have limited space; however, these concepts are used by seasoned gardeners as well. The greatest benefit of the system is the efficiency that it provides.

References and Further Reading

- Building a Rain Barrel* (HENV-201)
Gardening in Small Spaces (ID-248).
Home Vegetable Production in Kentucky (ID-128)
Jumikis, Alfreds R. 1984. *Soil Mechanics*. Krieger Publishing Company. Malabar, Florida.

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