



## Manual Pump System

# Macro-Infusion Guide

Macro-infusion rapidly introduces a large volume of solution directly into a tree's vascular system. Macro-infusion delivers complete and even distribution of solution throughout the canopy providing predictable results.



**Be certain to read ALL the instructions covered in this application guide.  
Refer to the appropriate product guide and product label for dosage and mixing instructions.**



This Guide is Enhanced with videos accessible through your smartphone. Simply scan the QR Code with your phone to view each video.

If you do not yet have a QR Code reader, there are many available for free through your phone's App Store. Contact us if you are unsure on how to utilize these features with your smartphone.

**Videos are available at: [youtube.com/RainbowTreeScience](https://www.youtube.com/RainbowTreeScience)**

for protocols, product guides, and  
technical support

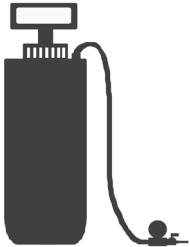
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# Equipment Checklist

Equipment	Recommendation or Use
<b>Manual macro-infusion pump*</b>	Manual macro-infusion pump
<b>75 infusion tees*</b>	Use 1 tee for every 1.5" of DBH. (Example: a 30" DBH tree would require 45 macro-infusion tees)
<b>3 connector tees*</b>	To connect plastic tubing into multiple pathways
<b>110' of tubing*</b> - 74 one foot lengths, 2 ten foot lengths 1 four foot section 2 six foot sections	To create the harness between the infusion tees 1/4" inside diameter – 3/32" wall size
<b>2 15/64" high-helix drill bits*</b>	Replace every 5 trees for best uptake and chemical
distribution	
100-300 feet of extension cords	For plugging in drill (if necessary)
Electric drill	Rainbow recommends 18 volt models
Wire or straightened paper clips	For unclogging tees
DBH measuring tape	For measuring a tree's diameter
Small rubber mallet	To lightly tap leaking tees
Spade	For excavating soil around the root flares
Hand trowel or V-shaped hoe	For pulling soil away from root flares
Hand brush	To clean soil off root flares
Rake and broom	For clean-up

\*These items are all included in our Manual Macro-Infusion Pump Kit (#5308).



**manual pump**  
**#5307**



**infusion tees**  
**#5311**



**connector tees**  
**#5312**



**tubing**  
**#5310**



**drill bits**  
**#5314**

## Replacement Parts

Item#	Item Description
5307	Manual Pump with Hardware
5308	Manual Macro-Infusion Pump Kit (manual pump with hardware and supplemental kit)
5309	Supplemental Kit (110 feet of tubing, 75 injection tees, 3 connector tees, 2 high helix drill bits)
5310	Tubing (110 feet)
5311	Infusion Tees (25 pack)
5312	Connector Tees (3 pack)
5313	Pressure Gauge
5314	15/64" High Helix Drill Bits

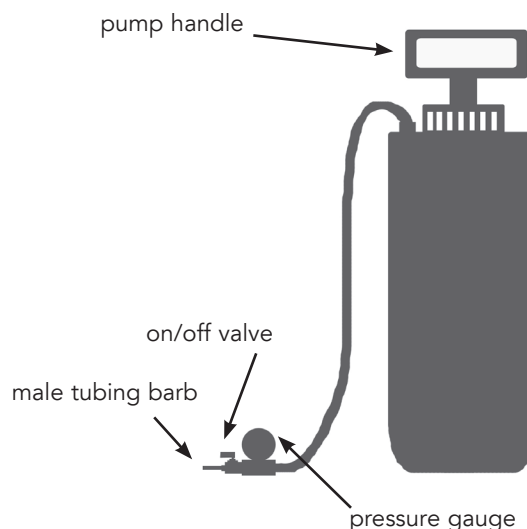
# Equipment Assembly

## Tools Needed:

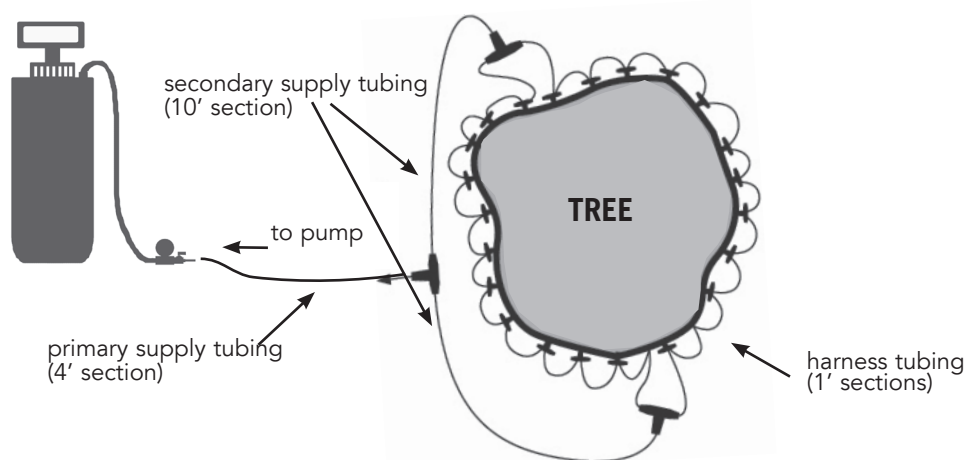
Hose cutter or knife  
Tape measure  
Bucket of warm water

## Assembly Instructions:

- 1) Cut tubing into the following lengths:
  - a) 74 – 1 foot sections (harness tubes)
  - b) 2 – 10 foot sections (secondary supply tubes)
  - c) 1 – 4 foot section (primary supply tube)
  - d) 2 – 6 foot sections (bypass tubes)
- 2) Assemble harness
  - a) Place one end of the tubing in hot water to soften. Insert infusion tees into the 1 foot lengths of tubing. Make sure to get the tubing over at least the first two ribs of the tees. Be careful not to puncture the tubing.
  - b) Attach all of the 1 foot lengths of tubing together with infusion tees to create the harness. The harness sections can be assembled or broken down to any size lengths depending on the diameter of the tree. It is easier to work with several smaller sections rather than one long section when setting up a tree for macro-infusion.
- 3) Assemble supply tubes to the pump
  - a) Attach 4 foot section of tubing (primary supply) to the male tubing barb on pump.
  - b) Attach connector tee to the opposite end of the primary supply tube.
  - c) Attach one 10 foot section (secondary supply tubes) to each side of the connector tee at the end of the primary supply tube.
  - d) Attach a connector tee to the opposite end of each secondary supply tube.



**Watch the Video**  
on assembling  
the equipment



# Macro-Infusion Protocol



Watch the Video  
**Step 1:**



Watch the Video  
**Step 2:**



Watch the Video  
**Step 3:**

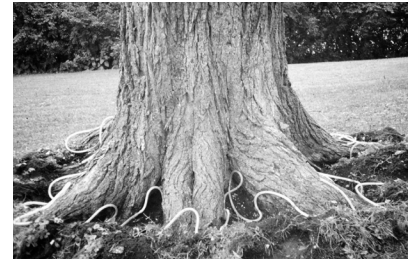


Watch the Video  
**Step 4:**



## Step 1: Inspecting the tree

- Inspect tree for girdling roots, root rot, or any other sources of stress that may be affecting tree health.
- Determine how much root flare excavation is needed to make the infusion sites 4-8 inches below the crest of the root flare. (**Fig. 1**)
- Not all trees require excavation if the root flares are visible.
- **DO NOT treat trees with significant rot or girdling roots.**
- Inspect canopy for significant canopy die back or stress. This may compromise uptake time and distribution.



**Fig. 1**

## Step 2: Determining dosage

- Refer to the appropriate product guide or product label to determine dosage.

## Step 3: Excavating the root flares

- Begin filling reservoir with required amount of water.
- Use a shovel or trowel to remove sod and soil without damaging the tree. (**Fig. 2**)
- Thoroughly brush soil from root flares using a coarse brush. (**Fig. 3**)
- **Soil left on the root flare can dull the bit, clog the holes, and increase uptake time.**



**Fig. 2**



**Fig. 3**

## Step 4: Drilling the infusion sites

- Use a clean, sharp, 15/64" diameter, **HIGH HELIX** drill bit. (*Change drill bit every 5 trees to ensure sharpness*)
- Drill perpendicular to the surface of the flare and **DO NOT** spin the bit in the hole unnecessarily. (**Fig. 4**)
- Spinning the bit will cauterize the vascular tissue resulting in slower uptake.
- Drill holes through the bark about 1 inch into healthy xylem tissue. (Depth will vary depending on bark thickness) (**Fig. 5**)
- Use 1.5 infusion sites for every DBH inch (approximately 1 infusion site every 4-6 inches) evenly spaced around the root flares.
- **Place at least one infusion site on EACH root flare**
- **DO NOT place infusion sites into or below dead tissue**
- **DO NOT drill into deep valleys or sunken areas**



**Fig. 4**

Videos are available at: [youtube.com/RainbowTreeScience](https://youtube.com/RainbowTreeScience)

# Macro-infusion Protocol

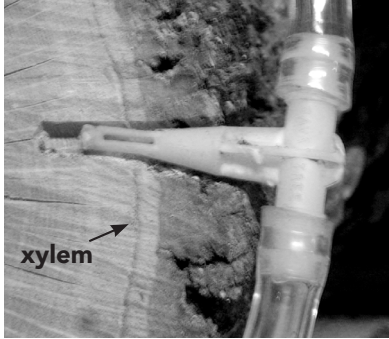


Fig. 5



Fig. 6

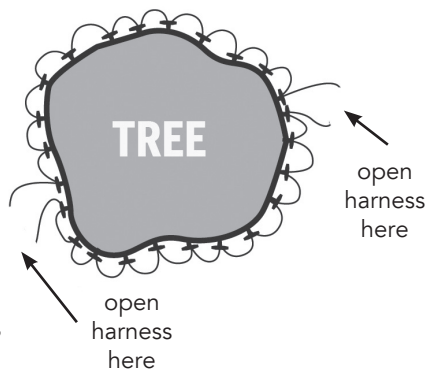


Fig. 7

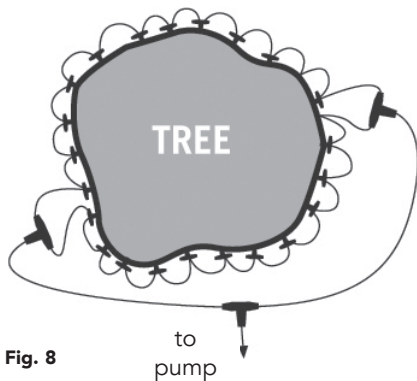


Fig. 8

## Step 5: Inserting tees and connecting the harness

- Check each tee to be sure it is not plugged and replace badly damaged tees.
- Firmly insert tees by hand into all infusion sites to form a continuous harness around the tree. (Fig. 6)
- **Don't push or pound tees too deep!**
- Open two sections of the harness on opposite sides of the tree. (Fig. 7)
- Attach the supply tubing from the pump to feed into the harness in these two locations.

## Step 6: Starting the infusion

- **Always begin infusion with water only.**
- Fill the pump with half the required amount of water that you determined from Step 2.
- Pull out two tees on opposite sides of the tree to purge the air out of the line. (Fig. 8)
- Pressurize the tank and purge the air from the harness.
- With all air out of harness, re-insert the two tees and check for leaks.
- If leaks persist lightly tap the infusion tees with a small hammer or rubber mallet.

## Step 7: Mixing the product

- Turn pump off.
- Add product and remaining water.
- Start infusion again.

## Step 8: During the infusion

- Maintain pressure at 15-20 psi using the pressure regulator.
- Monitor infusion sites for leaks.
- Lightly tap any leaking tees with a small hammer.
- If an infusion site continues to leak, drill a new hole or bypass it with a longer piece of tubing.
- Prepare other trees on site for treatment.

## Step 9: Cleaning up

- After all the solution has emptied and air is drawn into the harness, turn the pump off.
- Disconnect the supply tubes from the harness. Always keep the supply tubes connected to the pump.
- Remove tees from the tree and disconnect the harness in 6-10' sections for easier access next time.
- Replace soil and sod around the base of the tree.
- **DO NOT** treat drill holes with wound paint or other sealing compounds



Watch the Video  
**Step 5:**



Watch the Video  
**Step 6:**



Watch the Video  
**Step 7:**



Watch the Video  
**Step 8:**





# Troubleshooting

## Slow Uptake

- Use high quality water. Water of poor quality (dirty, high pH, etc) may significantly compromise uptake.
- Make sure the infusion is done on the root flares. If not, distribution and uptake will be compromised.
- Make sure the tees are not clogged from dirt and grit.
- DO NOT pound tees in too far, this will block the flow of solution to the active xylem.
- Check your drill bit. Use only clean, sharp, high helix drill bits. Dull drill bits may cauterize the xylem and result in slow uptake. Replace bits every 5 trees for best uptake.
- Water the tree a day before the infusion if drought stress is a problem. Drought stress may cause trees to transpire less. Maintain adequate soil moisture throughout the growing season.
- Make sure your spacing of injection sites is correct. Spacing should be 4-6" apart. Spacing over 6" will compromise distribution and uptake.
- Make sure proper dosing reductions were considered for major losses to the canopy size. Uptake may be compromised and phytotoxicity may result without proper reductions. Follow dosing guidelines as noted on product label or the product guide.
- Check for large air bubbles in the harness. Pull a tee near the air bubble to release. Large air bubbles will compromise distribution and uptake.
- Keep pressure between 15-20 psi.

## Leaking

- Check to see if any tees are broken.
  - The hole may have been drilled into dead wood. Re-drill higher up on the flare. If leaking persists, use a longer piece of tubing to bypass that injection site.
  - Look closely at where the leak is coming from. It may be coming from another hole in the tree such as a previous year's injection site.
- Plug a leaking infusion site by connecting a 12" harness tube to both ends of a tee to create a loop as shown.



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## Maintenance and Storage

- Store the pumps upright.
  - Do not store equipment in a vehicle for a prolonged period of time. High or low temperatures reduce longevity.
  - At the end of each application, make sure to flush water through the pump and harness to prevent build up of chemical in the system.
  - Do not store pump in temperatures below 41°F/5°C
  - If the pressure gauge shows a pressure when there should be none, vent the gauge by perforating the rubber seal at the top of the gauge to equalize the atmospheric pressure.
  - When testing the pump do not be concerned that the pressure gauge does not rise above 8-10 psi. This is due to the lack of resistance when the harness is not connected to a tree. To check the pressure gauge, cinch the end of the tubing to restrict the flow of water through the pump.
  - **Warning: Failure to follow these guidelines could result in pump malfunction.**
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technical support

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