PEE THE CHANGE!



Join our mailing list

tinyurl.com/RichEarthNewsletter

Take our community science survey

Join over 250 peecycling gardeners from around the world in sharing your experiences with reclaiming the power of pee!

tinyurl.com/UrineMyGarden

Donate

Rich Earth Institute is a small nonprofit dedicated to reclaiming the nutrients from our bodies as elements in a life sustaining cycle. We demonstrate that urine recycling is possible through our community-scale program, and support others in completing the nutrient cycle through research, education, and technological development.

Help us grow the peecycling movement!

tinyurl.com/SupportRichEarth

Contact us

info@richearthinstitute.org

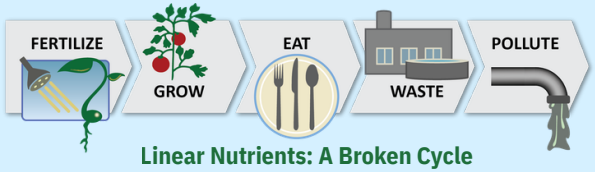
URINE MY GARDEN

Guide to Fertilizing with Urine

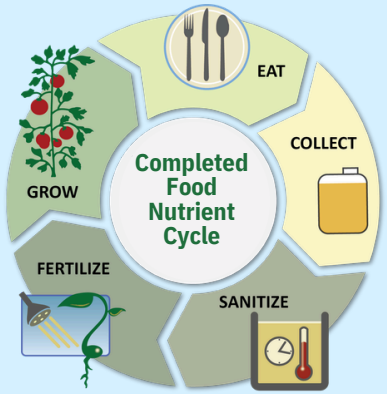


Discover why & how to reclaim the nutrients from your body for a flourishing home garden and healthier watershed!

Human urine contains the vital nutrients that plants need to thrive. When we flush these precious elements downstream, they are not only wasted but become pollutants that impair waterways, kill fish, and threaten drinking water. Instead, by collecting your urine (liquid gold!), your "waste" becomes a valuable resource. Urine fertilization has ancient roots and is practiced in many communities around the world today. By reconnecting linear nutrient flows back into the food nutrient cycle, we can transform a system of extraction and pollution into a cycle of abundance!



Linear Nutrients: A Broken Cycle





Fertilizing with urine can reduce our dependence on the fossil-fuel intensive production of synthetic fertilizers.



Separating urine at the source can remove up to 75% of nitrogen and 55% of phosphorus from wastewater.

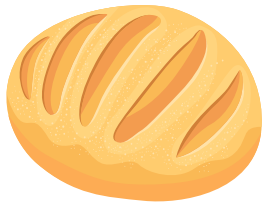


Every 5 gallons of urine collected conserves 100 gallons of flush water, or ~4,000 gallons per person each year.

"Give a gift, in reciprocity
for what you have taken.
Sustain the ones who sustain you
and the earth will last forever."

– Robin Wall Kimmerer
"Guidelines for the Honorable Harvest"

The nutrients in your daily pee are enough to grow wheat for a whole loaf of bread!



Reclaim

...what has been cast off as "waste" as a source of abundance
...a simple practice that has sustained communities for generations
...our role in the food system as not just consumers but forces of creation
...the power of our bodies to heal rather than harm the earth

To learn more about urine recycling at larger scales, read our companion guides: *Farmer Guide to Fertilizing with Urine* and *Community Guide to Urine Diversion Programs* (available on the Rich Earth Institute website).

Properties of Urine Fertilizer

NUTRIENT CONTENT

Urine is rich in nutrients, including the macronutrients nitrogen, phosphorus and potassium, as well as secondary and micronutrients. One gallon of urine contains 0.05 lbs nitrogen, 0.008 lbs phosphorus, and 0.017 lbs potassium. Agricultural field trials, including Rich Earth's own research on hay, have demonstrated that urine fertilizer provides crop yields comparable to synthetic fertilizers of the same nitrogen content.



Element	lbs/gal	%
Nitrogen	0.048	0.57%
Potassium	0.013	0.16%
Sodium	0.012	0.15%
Phosphorus	0.003	0.04%
Sulfur	0.0037	0.04%
Calcium	0.0002	0.0024%
Magnesium	0.00006	0.0008%
Boron	0.000016	0.0002%
Zinc	0.000003	0.0001%
Iron	0.000002	0.0001%
Copper	0.000002	0.0001%



While urine is used as a fertilizer, poop is rich in organic matter and can also be used as a soil amendment. Different state rules may apply to composting "humanure."

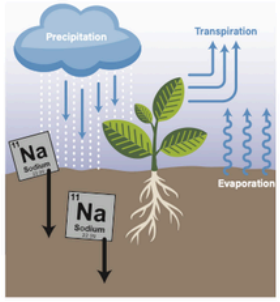
AMMONIA VOLATILIZATION

The main form of nitrogen in urine is urea, which is naturally converted to ammonia once it leaves the body. Ammonia is highly volatile, meaning it can easily evaporate out of the urine as ammonia gas when stored in an unsealed container.

To prevent ammonia volatilization from occurring–and retain the nitrogen content of your urine fertilizer–it is important to take care when storing urine and when applying it to soil. This can be done through storing urine in airtight containers, minimizing spraying during application, and integrating urine into the soil.



SALT ACCUMULATION



Urine contains significant levels of salt, but this isn't generally a problem for gardeners in humid climates, including the Northeast. In these climates, annual precipitation is greater than soil evaporation, with the result that rainwater/snowmelt will wash the salts out of the topsoil, preventing buildup of salt in the root zone.

However, if you are growing in an enclosed environment, like a greenhouse, or in an arid or semi-arid region, build-up of salts is a potential concern. We do not yet have recommendations for using urine in these environments. If you want to try it, be sure to monitor your soil for salt accumulation. If salt becomes a problem, you can periodically flush the soil with water through irrigation or a sprinkler system to correct it.

EFFECT ON SOIL PH

Urine is an ammonia-based fertilizer, and soil science suggests that adding ammonia to soil will either: 1) have no lasting effect on pH if plants absorb and utilize all the nitrogen from the fertilizer or 2) cause a drop in pH if a substantial portion of the nitrogen leaches out of the soil before it can be absorbed by the crop, due to excess irrigation or rainfall. These effects are related to the natural soil process that converts ammonia into nitrate.

Wool

Sheep wool can be paired with urine fertilizer to help the soil hold moisture while slowly releasing additional nitrogen as the wool decomposes.

Fermentation

Fermenting urine lowers its pH, turning more ammonia into plant-available ammonium and reducing nitrogen loss via ammonia volatilization. One way to do this is by adding small amounts of acid whey (a dairy by-product) and a starter culture, like a probiotic pill. Our research trials found that low whey rates (1 part whey to 8–16 parts urine) gave the best nitrogen retention for the amount used. Fermentation works faster in warm temperatures and slower in cooler ones.

BONUS USES

Aside from the benefits of fertilizing with urine, many home gardeners have reported additional uses for urine in the garden. (Rich Earth has not tested these potential benefits ourselves).

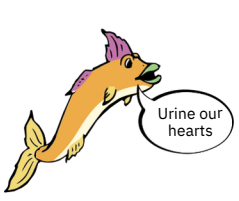
DETERRING PESTS:

Several gardeners report that fertilizing with urine can help reduce insect damage. One gardener said urine fertilization "helps the eggplants to outgrow the flea beetles." Some people also recommend pouring urine around the perimeter of the garden to discourage animals from entering or pouring about a gallon of urine down woodchuck holes, and repeating over several days. One study from the National Institute of Agricultural Research in Niger looked into the effectiveness of urine in deterring cowpea pests, finding that urine performed significantly better than the non-treated control, though worse than neem oil and synthetic pesticide.

HERBICIDE:

As anyone knows who's witnessed dog pee turn patches of lawn yellow, urine can also kill plants. This is a case of "too much of a good thing." Urine can act as an herbicide to undesired plants through nitrogen burning. One gardener reported that repeated applications of urine to Japanese knotweed (in conjunction with covering the knotweed with tarps) eventually achieved near eradication on their property. If urine is applied as an herbicide, it is important to consider application location to prevent contributing to nutrient pollution in nearby streams or other bodies of water.

At scale, urine diversion can be a powerful tool to reduce nutrient pollution in sensitive watersheds and provide local farmers with sustainable fertilizer. Urine recycling can take many forms, from decentralized collection points to building-scale systems. At home, urine diversion offers an actionable step to protect your watershed and nourish your garden while replacing the import of synthetic fertilizers. Whether this is the first step of your journey toward bringing urine recycling infrastructure to your community, or you're getting set up to fertilize your own garden, we're glad to have you onboard!





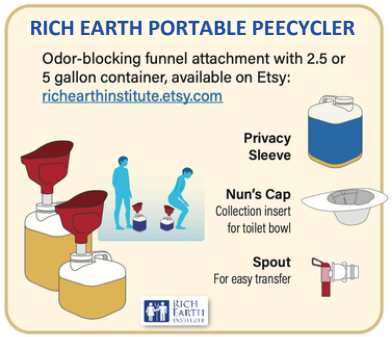


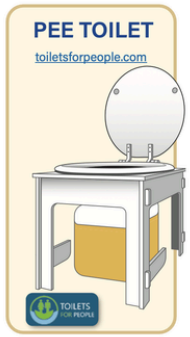
HOW TO FERTILIZE WITH URINE

1 Collect

Collect your urine fertilizer in a watertight, airtight container - this will prevent smelling and leaking, as well as any nitrogen loss during short-term storage.







The Rich Earth Portable Peecycler can be used for standing or squatting collection. A ball sits in the funnel, acting as a valve-check to allow urine to enter and prevent odor from escaping. Some use the funnel conjunction with a stand-to-pee device (such as the pStyle) or collect their urine in a nun's cap to pour into the funnel.

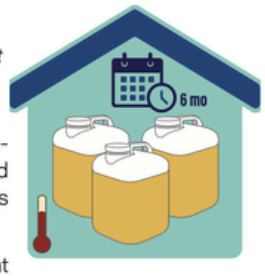
ODOR

Often, simply collecting urine in an airtight container is sufficient to prevent odors. If you notice a smell, you can optionally add 1-2 cups of white vinegar or 1 Tbsp. citric acid to your empty container.

2 Sanitize

Urine from healthy people is generally pathogen free. For home gardeners, **urine fertilizer does not need to be sanitized**. Many people use urine in their home gardens without any treatment. The World Health Organization supports this practice if the urine comes from the same household that will be eating the produce, and if the following guidelines are followed:

1. *Wash hands after handling urine, or wear gloves*
2. *Follow best practices for collection and application*
3. **Wait at least one month (30 days)** *after fertilization to harvest crops that you'll eat raw (such as leafy greens)*

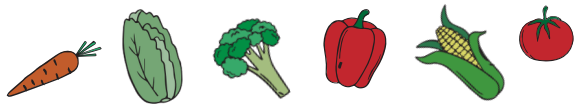


However, **sanitization is necessary** for growing food for public consumption. Contexts such as farms, community gardens, or schools should consult with your local or state regulatory agencies about any permits that may be required.

To sanitize your urine at home, simply store it in an airtight container at 68°F (20°C) or higher for six months. This will raise the pH in the urine high enough to kill any potential pathogens.

The Rich Earth Institute sanitizes our community-collected urine via pasteurization, heating the urine to 176°F (80°C) degrees for 1.5 minutes (US EPA method). This urine pasteurizer is available for larger-scale contexts via our spin-off company, Brightwater Tools.

3 Fertilize



When working with any fertilizer, it's helpful to keep in mind the "4R's" of nutrient stewardship: right source, right rate, right time, and right place. Having already delved into the source (the fertilizer factory within!), let's take a look at the remaining three factors.

RIGHT RATE

Any plant with high nitrogen needs is a great recipient for urine fertilizer–such as corn, tomatoes, and leafy greens. Many other crops–such as peppers, broccoli, cut flowers, shrubs, fruit and nut trees, and conifers–can also benefit from the range of nutrients in urine. To fertilize trees, apply the urine in a circle that is the same diameter as the tree's canopy (to estimate where the roots of the tree are growing below ground). Nitrogen-fixing plants such as legumes don't need to be fertilized with urine.

Some gardeners feel more comfortable starting with ornamental plants—like flowers, bushes, or grass—before trying urine on food crops. You can even use it on dye plants like indigo, as a way of enjoying the beauty of the nutrient cycle with your eyes rather than taste buds.

Figuring out how much urine fertilizer to apply is a match-making exercise between:

1. **Nutrient content of urine and any other ammendments applied**
   Urine is a high-nitrogen fertilizer - see page 2.
   Nutrient content of your soil
2. *State extension offices can provide soil tests and make recommendations.*
   Nutrient needs of your plants
3. *For crop-specific recommendations, check out* ***Cornell University's Nutrient Guidelines for Vegetables****.*



100 sq. ft. = 3.5 - 5.5 gallons *over the entire growing cycle*



Rich Earth's urine fertilizer calculator creates plant-specific guidelines for how much urine to apply per garden bed or square foot. Gardeners can use the calculator to create customized application recommendations by making a copy of the spreadsheet linked on our home gardening webpage: **tinyurl.com/UrineMyGarden**

You can also simply look for signs of nitrogen deficiency in plants, such yellow or pale green leaves or stunted growth, and apply accordingly. As a rough rule of thumb, an average 100 square foot garden can use between 3.5 - 5.5 gallons of urine over the course of the entire growing cycle.

RIGHT TIME

Most crops should be fertilized with urine during their more active growth stage. Generally, this means when the plant is older than a seedling but before it begins flowering or fruiting (nitrogen stimulates vegetative growth). Seedlings in grow trays or after transplanting can benefit from diluted urine fertilizer; we recommend mixing 1 cup of urine with 1 gallon of water.

Urine is a fast-acting fertilizer. Apply urine in several small applications spread out over the growing period (roughly every couple of weeks), rather than one large application. This provides the plants with nutrients as they need them, and gives them time to take uptake the nutrients before the excess runs off as pollution.

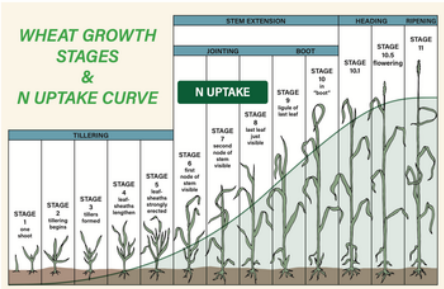


Illustration based on S.A. Ebelhar Illustration, University of Illinois

Due to the high nitrogen content of urine, we recommend applying the urine when the plant has its greatest nitrogen needs.

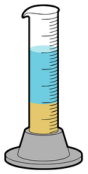
RIGHT PLACE

Apply urine directly to the soil rather than onto the plant to avoid nitrogen burning. Since the nitrogen in urine is easily lost to the air (through ammonia volatilization) it is important to incorporate the urine into soil as quickly as possible. This can be done through a few different methods:



- Apply urine in a hole or furrow at least 4" from the base of each plant and cover with soil
- Irrigate after application or apply during rain
- Dilute urine before application

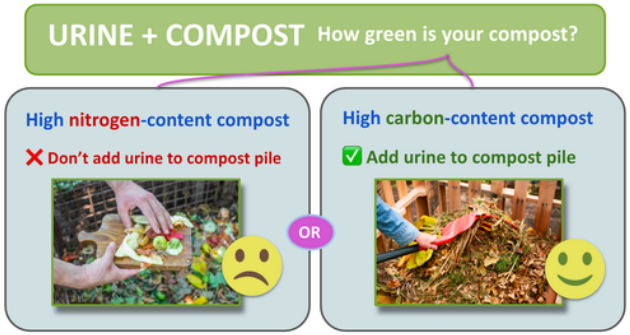
Dilution:



Many gardeners dilute their urine with water before applying. While this is not always a necessary step, it helps the urine soak into the soil, which is especially important in dry soil. Dilution can also help reduce the odor of the urine fertilization experience. Suggested dilution ratios (urine:water) range from 1:1 to 1:10, depending on the fertilization context and the dryness of the soil.

Reci-pees

Urine + compost



Adding urine can be an effective way to increase the nitrogen in a compost pile. If you have a high carbon content compost heap (mostly straw, dead leaves, sawdust, or other dry, dead plant material), then it will retain the nitrogen in urine fertilizer - and the urine can actually help accelerate the composting process. However, if you have a very green compost pile already (mostly kitchen scraps or green plant. material), then too much nitrogen can cause the pile to heat up too fast, kill microorganisms, and emit greenhouse gases such as methane and nitrous oxide.

Urine + biochar



Biochar is a charcoal-like substance with high capacity for retaining nutrients and storing carbon. Biochar can adsorb the nutrients in urine, keeping nutrients in the soil for longer.

Urine + wood ash

Wood ash is a great option for giving your soil an extra boost of potassium. Don't mix urine with wood ash (it will make the ammonia more volatile) but rather add both amendments separately to your garden bed as needed.

Urine + straw bale



Enriching a straw bale with urine fertilizer can accelerate the decomposition process and feed soil microbes.

Urine + wood chips

Urine can help biodegrade woody material and slow down their release of nitrogen.

Safety

Pathogens:

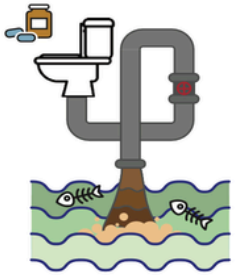
Urine from healthy individuals is typically pathogen free (though not truly sterile). Urine collected from your home is safe to use in your garden without sanitization, according to 2006 World Health Organization guidelines. If you live with someone who is sick, you are far more likely to be infected by sharing a household and bathroom with them than through eating urine fertilized produce. However, if you are using urine collected from a urine-diverting toilet, fecal contamination is possible. *See "Step 2: Sanitize" (Page 4) for more information.*

Heavy metals:

Heavy metals are low to non-detectable in urine; much lower than some other common fertilizers, such as commercial phosphate fertilizers, manure, and biosolids.

Pharmaceuticals:

Urine can contain pharmaceutical residues. When we flush urine into wastewater systems, these chemical compounds are generally not removed and accumulate in downstream water bodies with disruptive effects on the species who live there. By diverting urine from the wastewater stream, we can protect these sensitive aquatic ecosystems and water supplies.



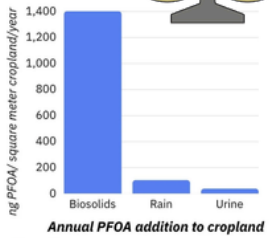
When urine is applied to the soil as a fertilizer, our own research and a number of other studies have not found pharmaceuticals to accumulate in crop tissues at significant levels. While there are some pharmaceutical compounds detectable in crop tissue, the levels are extremely small–in the nanogram per gram (or parts per billion) range. Perhaps unsurprisingly, caffeine is by far the most abundant drug found in human urine. But the molecule is present in such tiny amounts in urine-fertilized lettuce that you would have to eat a pound every day for 1,000 years in order to ingest the equivalent of one large cup of coffee. The levels of other pharmaceutical compounds are even lower than this.



Research findings suggest that soil microbes may be helping to break down the pharmaceuticals. Rich Earth is now conducting research to better understand how fertilization affects soil microbial communities.

PFAS

Some levels of PFAS may be present in urine, since they are common in human blood and leave the body slowly over time. However, urine contributes negligible amounts of PFAS to the soil (and much less than other common agricultural inputs such biosolids and irrigation water). Research has shown that there is PFAS (most notably PFOA & PFOS) in all soils at background levels. The amount of PFOA & PFOS added by a year's worth of urine fertilization is less than 0.1% of the levels already present in the soil.



Annual PFOA addition to cropland

