Trialing (Human) Urine Fertilizer with New Crops:

A SARE Partnership Project

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Is human urine organic?

1. Organic regulations work by either explicitly allowing synthetic substances, or explicitly prohibiting nonsynthetic substances. "Sewage sludge" is one of the nonsynthetic substances that is explicitly prohibited. Here is the definition of sewage sludge:

   > "***Sewage sludge***. *A solid, semisolid, or liquid residue generated during the treatment of domestic sewage in a treatment works. Sewage sludge includes but is not limited to: domestic septage; scum or solids removed in primary, secondary, or advanced wastewater treatment processes; and a material derived from sewage sludge. Sewage sludge does not include ash generated during the firing of sewage sludge in a sewage sludge incinerator or grit and screenings generated during preliminary treatment of domestic sewage in a treatment works."*

2. Human urine that has been diverted from the waste stream is not covered under the sewage sludge prohibition. Legally, if it's not prohibited, it's allowed. However, in our experience so far, most certified organic producers have felt the need to be cautious about using urine, so our work has primarily been with those who practice organic methods but are not certified, or conventional farmers.

SARE Field Day, Sept, 2021

Adam Hubbard's hemp crop was the site for our field day reporting results

Drip Irrigation Trial at Rich Earth Institute

For this experiment, we tested the reliability of urine fertigation with 3 different types of drip emitters:

- AquaTraxx medium flow drip tape, 60 GPH/100’
- DripWorks Take-Apart 1 GPH emitter, cleanable
- DripWorks Non-Plugging 1 GPH emitter, clog-resistant

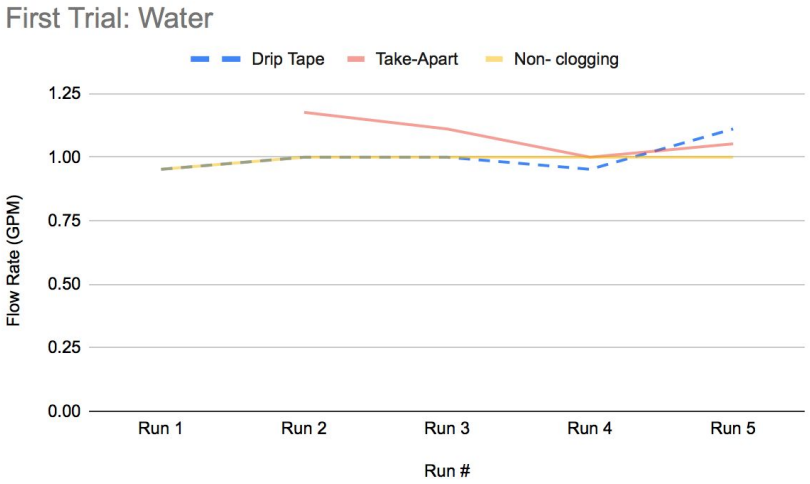
For each of these emitter types, we used 3 treatments:

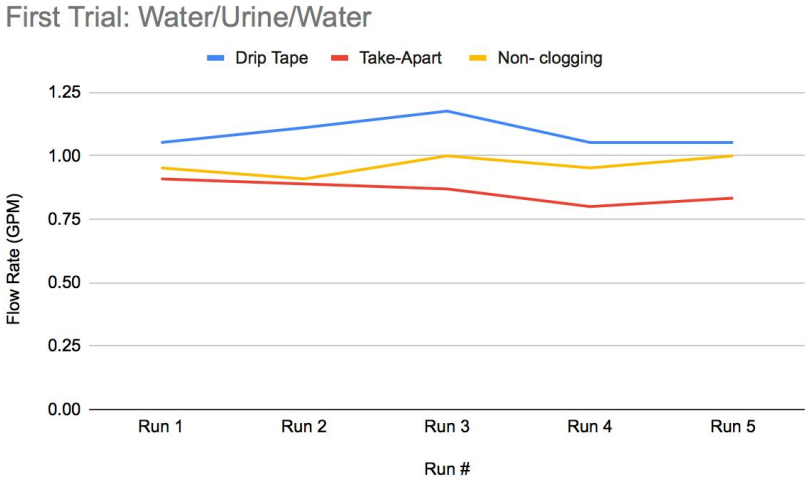
- Water-only control
- Urine/water mix, followed by water rinse
- Water, then urine, then water (not mixed)

<u>Experimental goal:</u> to determine optimum method and materials for using urine in a drip fertigation system without clogging the emitters

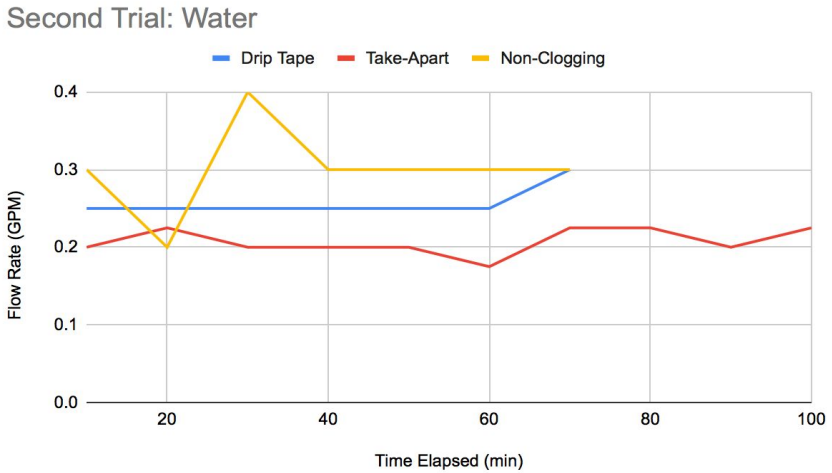
Our experimental set-up

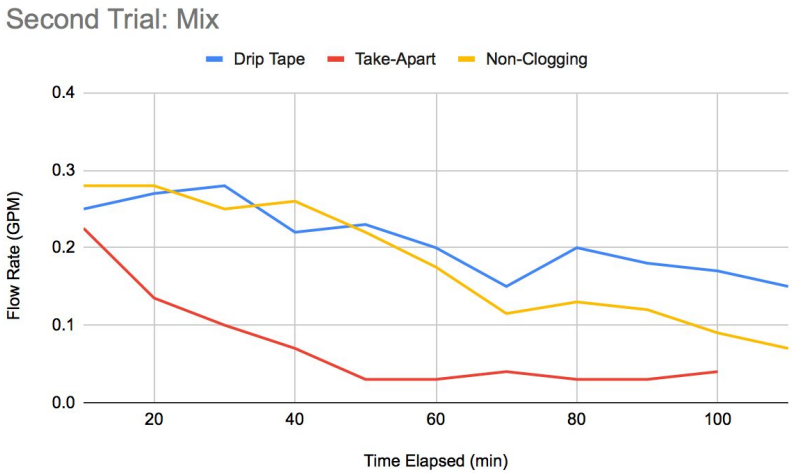
First Trial: We did five consecutive irrigation sessions for the nine combinations of emitter and application method. We measured the amount of time it took to apply 20 gallons of 124 ppm hard water (or water + urine) and used that measurement to calculate flow rate. These graphs show that flow rate did not change significantly for any of the emitter and application method combinations over the course of the five irrigation sessions.

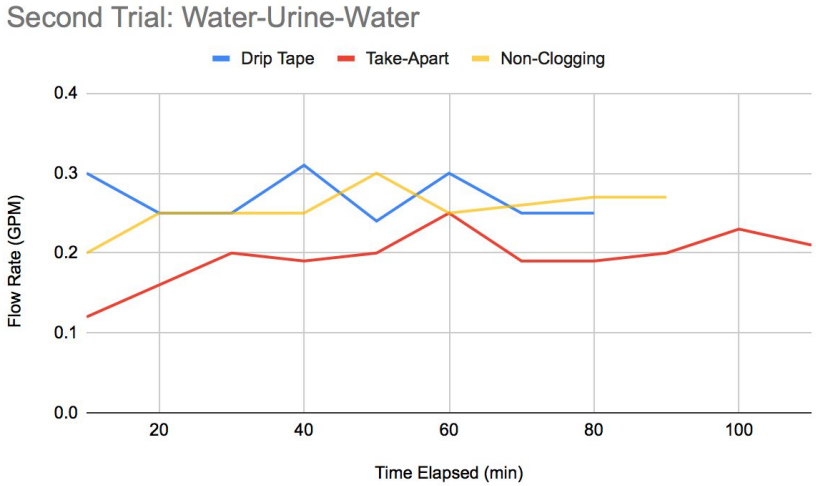




Second Trial: We increased the water hardness to 255 ppm and did a single, longer run for each emitter/application method combination. For the Water-Urine-Water treatment, we did a single, long injection of urine into the line instead of 5 smaller ones. We can see that the Mix treatment resulted in a decreasing flow rate across all emitter types (worst with the Take-Apart emitters), while the Water and Water-Urine-Water treatments showed no decrease in flow rate in any emitter type. (Absolute flow rates are lower than the previous trial because fewer emitters were used in each test configuration.)







Conclusions

- For irrigation water with a hardness up to 124 ppm, urine can be used for fertigation mixed in with irrigation water or alternating with irrigation water using drip tape or non-clogging (non-plugging) emitters. Though take-apart emitters appear to be viable with water up to 124 ppm, flow may be reduced more quickly than with the other emitter types.

- When fertigating using urine and irrigation water with hardness above 124 ppm, the urine and water should be pumped into the irrigation system in an alternating sequence, to minimize mixing. All three emitter types seem to work well under this usage, but the take-apart emitters appear to be more inherently prone to clogging than the other two types.

Farm Partners:

- **Tapalou Guilds**: Hanna Jenkins and Andy Loughney - Fertilized cut-flowers and hemp using hand-application
- **Elm Lea Farm:** (Putney School): Pete Stickney - Fertilized hay with Rich Earth Institute's liquid "band" applicator
- **Rebop Farm**: Ashlyn Bristle and Abraham McClurg - Fertilized greenhouse-grown figs using hand-application--prospects for future drip fertigation
- **Hubbard CBD:** Adam Hubbard - Fertilized CBD hemp using drip tape fertigation
- **Pete's Stand:** John Janiszyn - Fertilized sweet corn by subsurface side-dressing of urine during cultivation

Hubbard CBD

Adam Hubbard

Motivation for getting involved…

"We talked about what the grant was looking for, and what you were looking for as an organization, and what I needed… It seemed like a pretty good fit, setting up a comparable measurable system is intriguing to me… you know, the scientist in us, wanting to know things… and learning is expensive, it takes time and effort, so [we were]*trying to work out a system that minimizes my effort but gets results, and it's fun! "*

Elm Lea Farm

Pete Stickney, Farm Manager

Motivation for getting involved…

"I get a lot of pride and satisfaction in growing grass on side-hills and having cows turn it into beautiful milk…. so I'm really keen on the process of putting manure or urine or anything like that onto pasture, and by association hayfield, [and] certainly, absolutely, if we can keep a resource out of the Connecticut River and out onto the hayfield, all the better!

And I also want our students to be engaged in it, and any faculty and staff who are interested… I have a little more help and a little more equipment than conventional farmers who are trying to turn a profit… quite frankly, I have a little more time to experiment"

Pete's Stand

John Janiszyn

Side-dressing corn with "injection" fertilization method during cultivation of sweet corn in Westminster, VT


Close-up
view

Motivation for getting involved…

We wanted to trial urine on corn, so we asked John… Luckily, he said "yes"!

"Yeah, I had this land here, this part by the treeline, it doesn't get as much sun, so it's not the prime spot on the field, so I figured I could give this bit for experimenting, over here…."

Rebop Farm

Ashlyn Bristle & Abraham McClurg

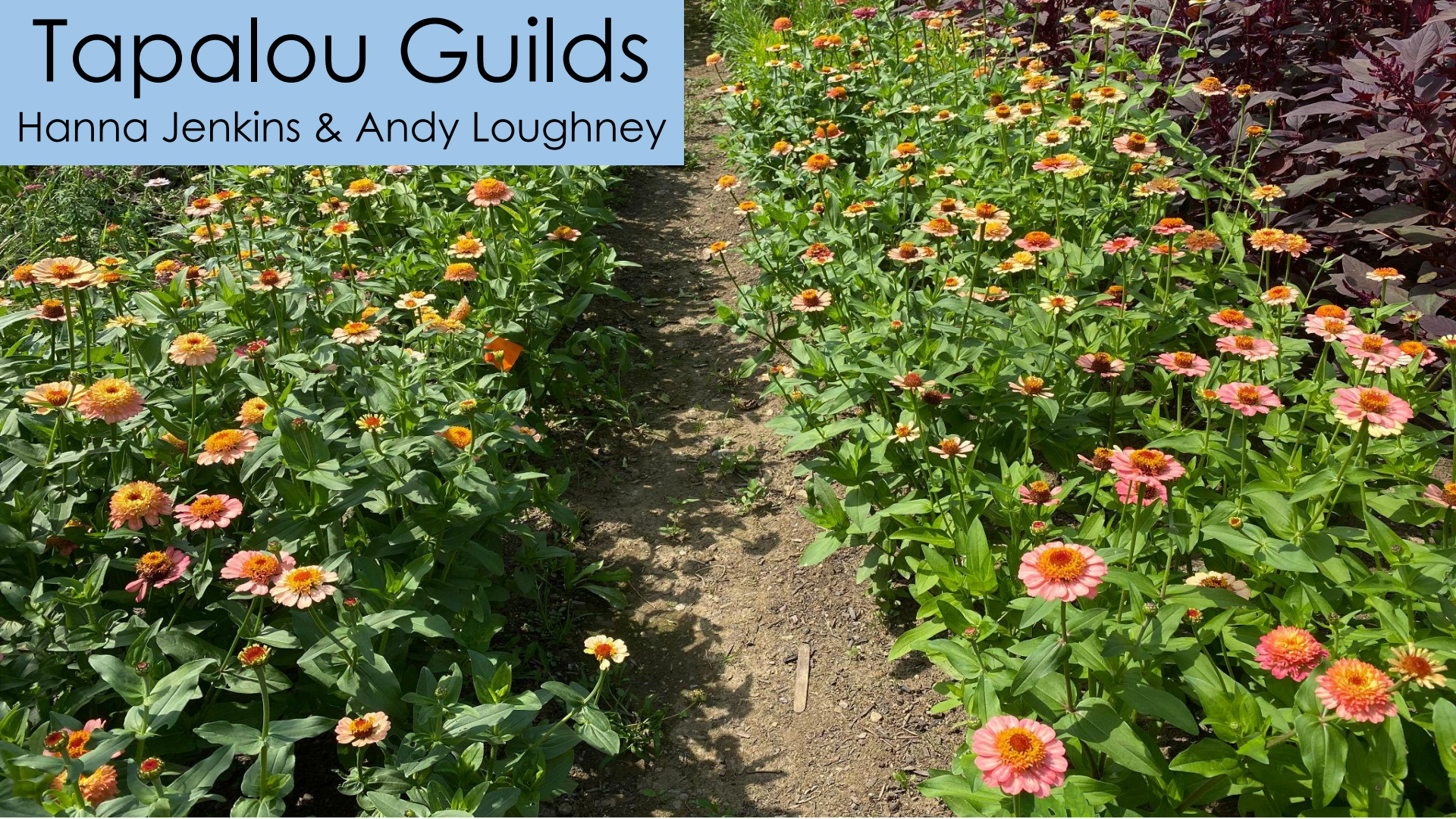
Figs grown in a high-tunnel in Brattleboro, VT.

Motivation for getting involved…

"Because these [figs] *die back every year in the winter and restart their growth, I felt like what we really needed was a lot of nitrogen to hit the ground running really quickly. We have a lot of fertility available because of all the animals…but the salt buildup was concerning to me with the bedded pack over time and so I thought maybe something quicker, more like a flash… and less long term or some combination would be a better fit."*

Tapalou Guilds

Hanna Jenkins & Andy Loughney



Motivation for getting involved…

Andy: "*We're always looking for closer to home sources of amendments, fertilizers, things like that, and closing the loop is really important to us, so when the opportunity came to have a little experiment, it seemed like an exciting thing to do…"*

Hanna: "*Just looking at the resources that are readily available…one of the things for me is to look at things that may be defined or understood from a dominant standpoint as 'waste' and* [thinking about] *how we can reclaim things that we might label as wasteful and then through simple processes make them useful again…."*

Social Research Component

Mid-season and final interviews with our five farm partners

How did you decide what you wanted to do?

Hanna: "*The plants that I chose, I looked at plants I had last year that I had a hard time with, I wanted to look at and see if the application of urine would help to combat any disease or pest pressure that they were facing.*"

Andy: "*Hemp is my primary crop that I focus on, so it made sense to see how urine contributed to their growth, especially because I don't do much amending from an NPK standpoint, I just apply compost tea,* [which is] *more a biological inoculant… but I know a lot of other farmers do apply nitrogen, so* [I was just curious] *to see if it did affect the growth… and, I found a paper that did some studies on N application and the final cannabinoid content of the plants, so* [I wanted] *to see if it actually changed the cannabinoid content of the plants.*"

How did the collaboration go?

- Andy (Tapalou): *" … there seemed to be an understanding of what summer looks like for farmers, so it was like two applications,* [Arthur] *came with a set of jugs, with lines on them, very straightforward, very simple, so we didn't have to think too much about the basics…."*

Adam: *"In order for it to work, it has to be profitable, I want there to be some benefit without just spending time. Arthur and Abe were conscientious of that… I don't have a lot of complaints, actually I really like, I like the possibilities here."*

What results were farmers seeing in mid-late August?

- Ashlyn: *What I'm seeing is a lot of success in the sections that are urine-[treated], have the heaviest fruit set, the best growth, we haven't gotten to ripe fruit yet or any kind of weighing, but what so far, what I'm seeing…it's spectacular, fruit all the way down.*"

- Pete: *It's very obvious from the dark green here where the urine was applied, dark green in the foreground, lighter green in the background, that's manure only… the entire field was covered with manure…*[that's] *a rather striking line here…*

Tissue sample results - corn

The N and P were similar in all the samples (except N was lower in the control), but there was a fairly sharp difference in the potassium. It was much lower in both the control and the conventional as compared to the urine treated samples. Also, sulfur was somewhat lower in the control and conventional as compared to all the urine treatments. In addition, iron, manganese and zinc were all higher in the urine treatments as compared to both control and conventional (and treatment raised the zinc from low to normal in one case, and manganese from borderline low to normal). This suggested to John that urine treatment may be valuable with regard to these secondary nutrients, and important with regard to supplying sufficient potassium, perhaps reducing the need for side dressing.

Andy: Tissue samples for hemp

"Just got the test results back and they are exciting! The 6% overall rise in cannabinoid content is solid, but the real excitement comes from the huge gains in the cannabinoid that this variety was bred for (CBDV)... Big gains: 32% in the lo-N, 25% in hi-N trial.

A lot of the other percentages look big at first glance, but they started as such trace amounts that I don't think it's an accurate portrayal and I'm quite pleased with the numbers for the CBDV and overall cannabinoid content.

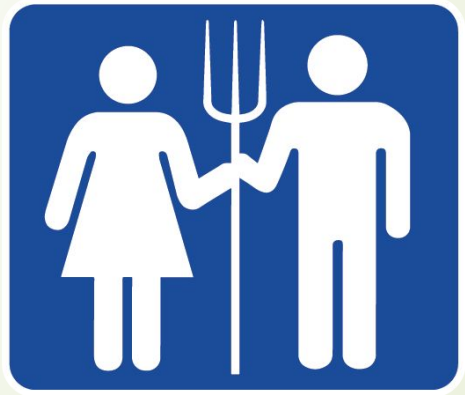
We will certainly explore nitrogen application at this point, even if it cannot be urine for our organic operation at this juncture."

Cannabinoid (mg/g)	Control	Urine (low dose)	Urine (high dose)	Compost Tea
CBDVA	43.4	57.5	54.2	45.7
Total	166.8	176.8	177.6	164.6

How did you talk to people about it? What were their reactions?

- Ashlyn: *I'm sure that it will be an issue for some people, but I think that the realities of food growing and where fertility comes from have to be a little bit more accepted if we want to eat and survive; we have to be a little more open as a general public, and as farmers it's really helpful when we're transparent about it.*
- John: *I mean, I'm not shy… I think it's a good idea, and so I would just, you know, I would probably come from a place of saying "Yeah, I think this is a great thing, I'm glad to be a part of this project, trying to figure out how to use this thing we're just sending down the drain, you know, we gotta change, we gotta start re-thinking on how we source our fertilizers, and you know, everything, really.*

Questions???



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The Rich Earth Institute engages in research, education and technological innovation to advance the use of human waste as a resource.