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Food Waste Derived Digestate Greenhouse Experimental Design

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Sarah Kakadellis¹, Kieran Heeley¹, Christopher Simmons¹, Edward Spang¹

¹University of California, Davis



Kieran Heeley

university of California, Davis

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We use this protocol and it's working

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Disclaimer

This protocol was developed using tomatoes in Huron, California, some areas, such as growth time or water requirements, may vary for other crops or environmental conditions.

Abstract

This document outlines the protocol to follow to demonstrate the use of pasteurized food waste derived digestate (FWDD) as liquid fertilizer in community learning gardens, as a means of promoting sustainable urban agriculture and social resilience. This method was developed for a trial using tomatoes, as part of **a publication** in the Journal of Agriculture and Food Research.

Guidelines

When taking pictures, it is essential to **keep the same angle, zoom and framing** across all pictures taken on a given day to ensure consistency. When choosing these settings, use the highest plant first to make sure all plants will fit in the frame.

After you have fixed the frame, take a first picture with a meter (without any plant) for calibration. This will help determine the real-life size of the frame for all pictures.

Then, take one picture for each plant against a white background, making sure all plant parts are in the frame and keep at eye level as much as possible, as in Fig. 5 below. If you are using a stick, make sure it is painted **white** (or, alternatively, black). Make sure each plant is labelled so we can identify it.

Upload images on a Google Drive folder and send the link to the folder with sharing permissions. Ideally, when uploading the files, rename them based on the system: "week#_plantID.jpeg". For example:

*"**week023.jpeg**" for plant ID 23 taken on February 12, 2024 (day 0), in a JPEG format. The calibration picture will have a number index of 0, e.g. "**week00.jpeg**".*

Materials

1-gallon pots, compost, pasteurised food waste derived digestate, sand, vermiculite, filtered water, fertiliser granules, Jiffy pot, Ziplock bags, drip irrigation system, seedlings of desired crop.

Before start

Environmental variability needs to be kept to a minimum, including temperature extremes, relative humidity, and irrigation pattern. Use an electric heater to keep temperatures above 50-55°F, and a fan/cooling system in the summer to bring temperatures below 85-90°F. Use misters if relative humidity is below 60%.

It is essential to **keep pots in the same arrangement throughout the experiment**. Take extra care on days height measurements and pictures are taken.

Protocol

- 1 1-2 day(s) before transplantation, prepare 1-gallon pots with appropriate soil treatment:
 - 1.1 **Positive control (treatment 2):** for each pot (17 total), mix  245 g filtered water +  44 g 16-16-16 fertiliser granules (this is to match the 7.02g total N present in treatments 3 & 4) +  1055 g sand +  151 g vermiculite. Mix the granules with the water before mixing them with the sand for a more homogenous spread.
 - 1.2 **Negative control (treatment 1):** for each pot (17 total), mix  245 g filtered water +  1545 g sand +  155 g vermiculite.
 - 1.3 **Compost only (treatment 3):** for each pot (17 total), mix  600 g compost +  245 g filtered water +  1000 g sand +  100 g vermiculite.
 - 1.4 **Compost and digestate blend (treatment 4):** for each pot (17 total), mix  540 g compost +  245 g digestate +  1055 g sand +  105 g vermiculite.
 - 1.5 The relative composition of each substrate was determined by the N content and volume of FWDD to keep total N content and water application constant across treatments (except in the negative control).
- 2 Refer to the layout template to label the 64 pots according to the allocated soil treatment plan (note that pots 65, 66, 67 68 will be used for soil sampling only and will not contain any plant) – be extra careful as this is a crucial step in the experimental design!

Updated design 4: 1 block = 4 x 4 Latin square (1 treatment per row and per column)

Treatment levels:

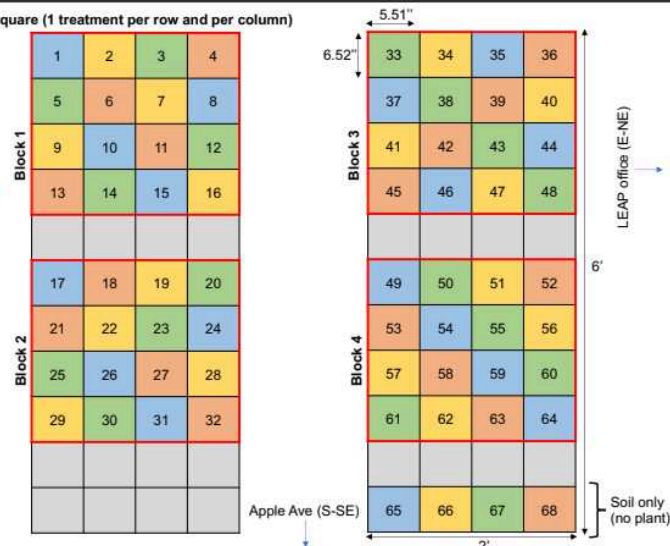
Negative control (growth medium only)

Positive control (growth medium + mineral fertilizer)

Compost (growth medium + compost)

Blend (growth medium + compost/FWDD* blend)

*Food waste-derived digestate



Layout template

- 3 Let the pots air naturally at least overnight.
- 4 Once the seedlings are ready to plant, transfer them to the pots. Select 64 seedlings of similar height from the 80-100 germination pots. Carefully peel off the Jiffy pot and transplant seedlings into 1-gallon pots. Disturb the roots as little as possible during this step. Water generously.
- 4.1 For tomatoes, this is once seedlings have developed their first set of true leaves (not the dicotyledon, or twin seed leaves,) and are 2-4 inches tall.
- 5 Insert white support sticks following the experimental layout and water generously with filtered water.
- 6 Record date of transplantation (this will be the day 0), record height for all 64 pots using the provided template and take pictures following the photo booth guidelines. Measure the plant height from the base of the stem (at the soil surface) to the apical part of the plant (the tip of the bud of the main stem). You may lift and support the stem by hand if needed, but you cannot lift or extend leaves. Record the height measurements in the attached file. [USDA_CIG_Height_Template.docx 3.3MB](#)



- 7 On the same day (day 0), take a handful of soil from the 4 extra pots without plants (pots 64-68, 1 for each soil treatment) and store in Ziplock bags for analysis.
- 8 Arrange pots following the experimental layout, making sure the number is correct.
- 9 Irrigate pots with filtered water once daily  500 mL through drip irrigation (or manually, if there are only overhead sprinklers). You may need to shift to twice daily and extend to  1 L or more in the warmer months, based on how dry the soil feels. Record any changes in the irrigation pattern, as well as the date changes were made.
- 10 Record height and take pictures every 2 weeks, starting from day 0, using the template provided in step 6. Until the final experimental day. Follow the photo booth guidelines at the end of this document. Do not change the camera setup between pictures!
- 10.1 For example, if day 0 is Monday, 02/12/2024, then record on 02/12/2024, and then every other Monday, so 02/26/2024, 03/11/2024, etc.)
- 10.2 2 week timeline based on the growth of tomatoes, faster growing plants this should be reduced to ensure enough data.
- 11 Plants will start showing signs of physiological stress after 2-3 months. When these symptoms occur, record the date. Continue irrigating all plants under the same irrigation regime but start adding 150 ml/5 oz fertilized water (NOT digestate) once a week.
- 11.1



tomato leaf with nutrient imbalance/deficiency

- 12 After 5-8 weeks, flower buds will appear. Using the template provided (fruit yield template), record the date of the first flower has bloomed for each plant (there will likely be a range between individual plants).
- 13 When the first fruits have ripened and are ready to harvest, record the date, the total number of fruits per plant and total weight per plant (some plants will have none), using the attached template. For each harvestable plant, take a picture of the tomatoes harvested, making sure you label them with their corresponding plant ID – **do not change the camera setup in between pictures!**  [USDA_CIG_FruitYield_Template.docx](#) 3.3MB
- 13.1 After 3-4 months, tomato fruits will have grown on certain plants, this timeframe may vary for other crops.
- 14 For each harvested plant, keep 3 fruit aside and label them. Protect them tomatoes with shock absorbing materials and send for analysis.
- 15 Repeat step 17 on the same weekday one or two weeks later depending on how many fruit are ready to be harvested, and again on the final experimental day.
- 16 Once the experiment is over and after final height measurements and pictures were taken, gently remove plants from pots, cut off the stem and leaves, and rinse roots in water to remove any soils particles as much as possible, then put aside to dry. Make sure you label the roots based on their respective plant ID. Send the roots for further analysis.

Photo booth guidelines

- 17 When taking pictures, it is essential to **keep the same angle, zoom and framing** across all pictures taken on a given day to ensure consistency. When choosing these settings, use the highest plant first to make sure all plants will fit in the frame.
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17.1



Example of plant photo for image analysis