Hopyard Composting: Art or Science?

Shane Bugeja
UMN Extension
Blue Earth/Le Sueur County

What is composting?

Controlled decomposition

- Make microbes work for us!
- US Composting Council

Compost uses:

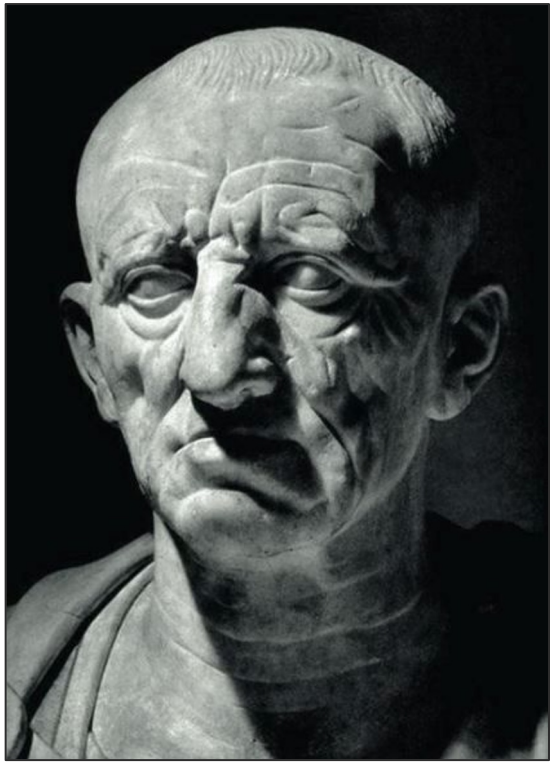
- Soil improvement
- Reducing food waste

Makes weak fertilizer

Ancient Roots of Composting

"You may make compost of straw, lupines, chaff, beanstalks, husks, ilex (holly), and oak leaves."

-Cato the Elder, "*De Agricultura*", 160 BCE



Get one more “cycle” for plant nutrients…

Plants are not picky

- Organic vs. inorganic

Many fertilizers are very C intensive

- Haber-Bosch process for nitrogen

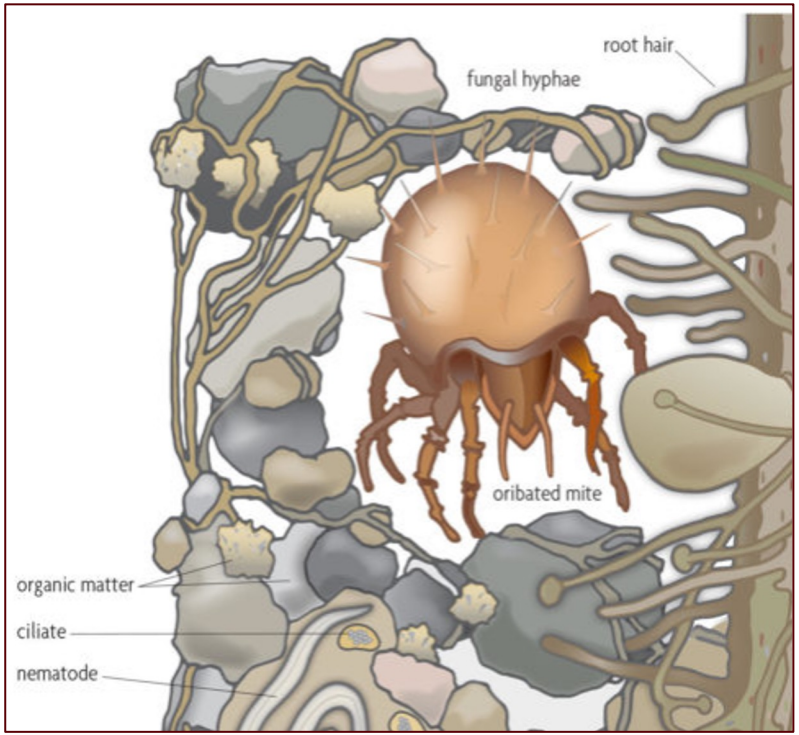
Burning or throwing away residue => nutrient/fertilizer loss

- Compost can save a small %

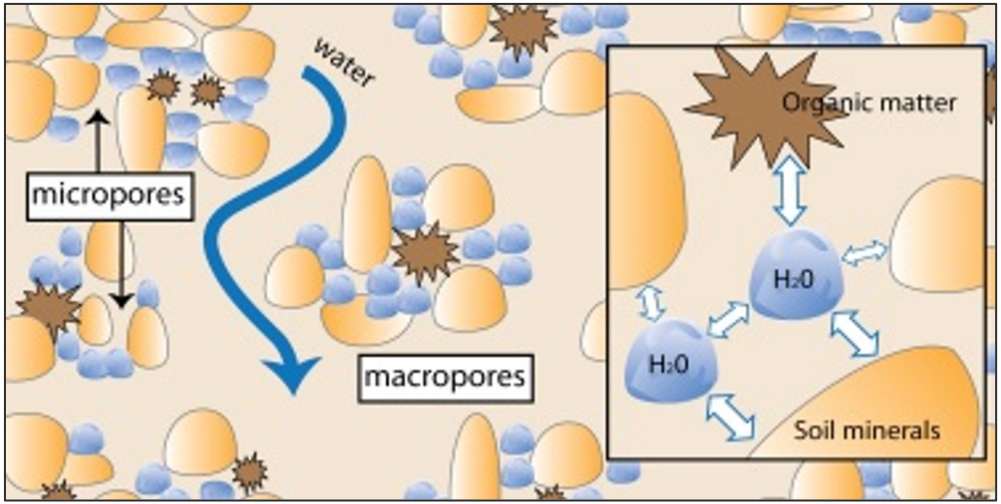
Fritz Haber

What do you do with your hop residue?

Compost => Organic Matter Input



Soil illustration: Wendy E. Giminski, SARE



Queensland Government: Environment, Land, and Water

Composting is an art as well as a science…

Much depends on **what** you compost

- No one has a laboratory on the farm

Many “tips and tricks” abound

- Some more fact based than others…

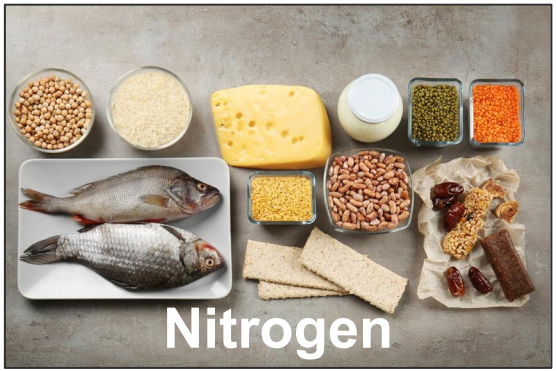
Treat these are guidelines, NOT law

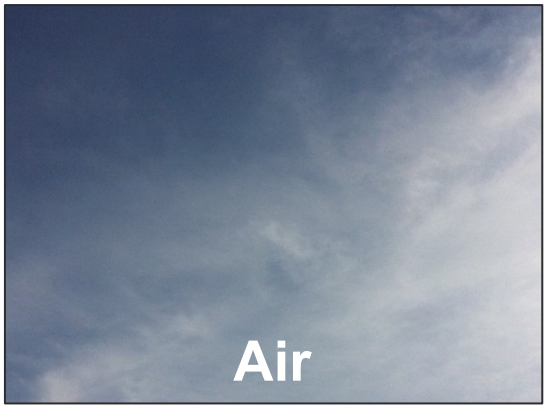
- Differences even between extension services

We want to make (certain) microbes happy!

Carbon

Temperature is important too!





Cold vs Hot Composting

Cold takes MUCH longer

- Trenches, pits, sheets
- Well drained soils
- Tweaked decomposition

Hot composting is very active

- Aeration, watering, mixing
- Controlled decomposition

Carbon and Nitrogen

"Browns" and "greens"

Not necessarily color

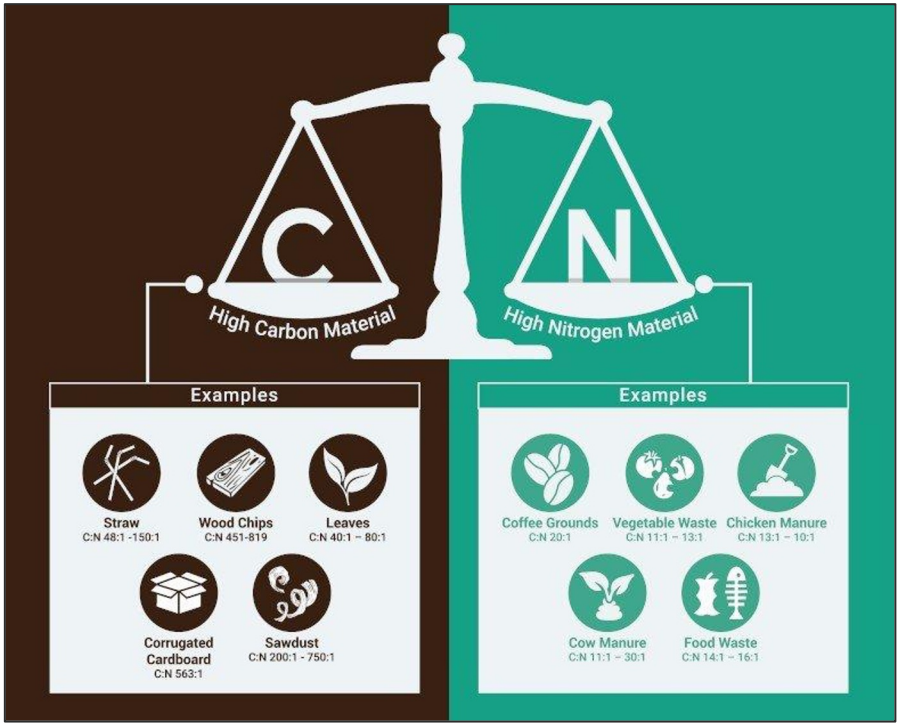
Carbon to nitrogen ratios

Greens are < 30:1

Browns are > 30:1

Brown to green ratios

3:1, 2:1, or 1:1?



Why there is no easy answer…

Initial pile goal => 30:1 C to N

- Faster, less smelly, less wasted N

But C to N ≠ browns to greens

- Dry weights often not known
- Book C:N values can vary in real life

Observation is key

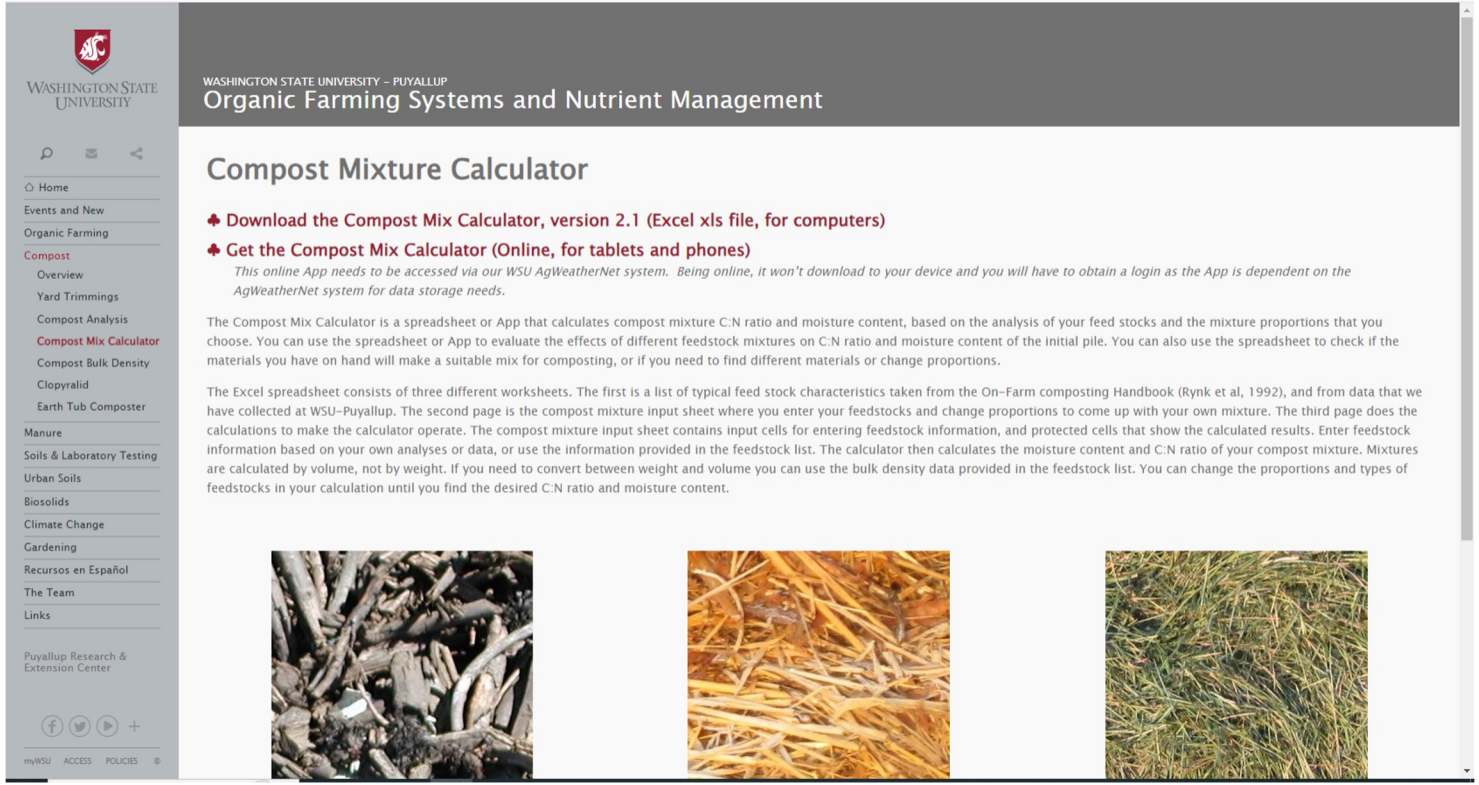
Hop residues are very “green”.

C:N ratio around 11:1 or 12:1

2 to 3% nitrogen for leaves/stems
- Corn is about 1%
- Lots lost during composting

Common hop compost “partners”
- Straw
- Cow/horse manure
- Twine (coir, sesel, etc.)

Calculator for Mixing Varied Composts



Water Use in Composting

Often missing in many piles

- 40-60% moisture

Need more than you think

- “Wrung out sponge”
- Count weather/rainfall

Holds shape when squeezed

- Water should NOT gush out

Aeration/Turning the Pile

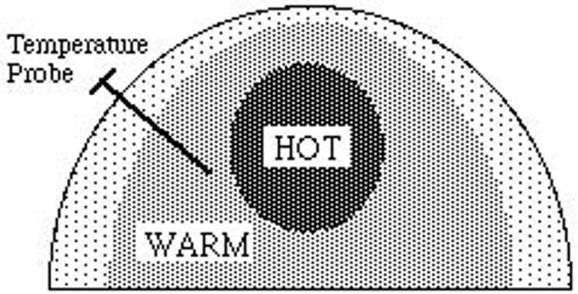
Most labor intensive

- Aside from application

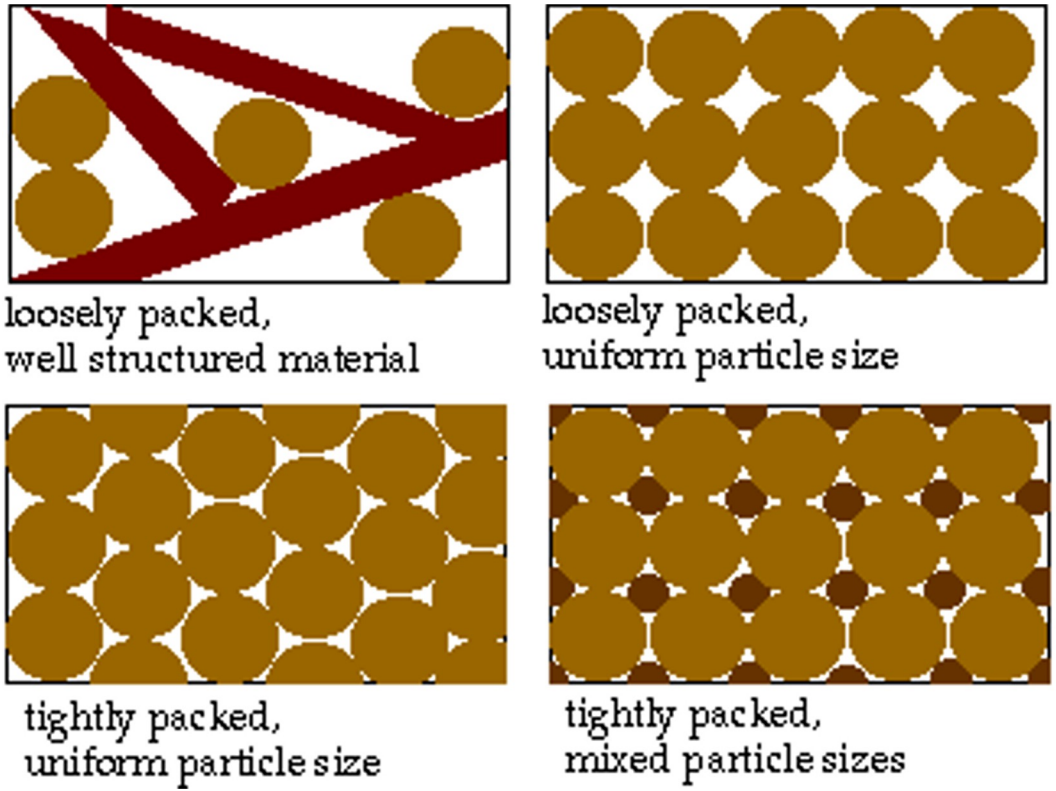
Oxygen gets depleted faster in middle

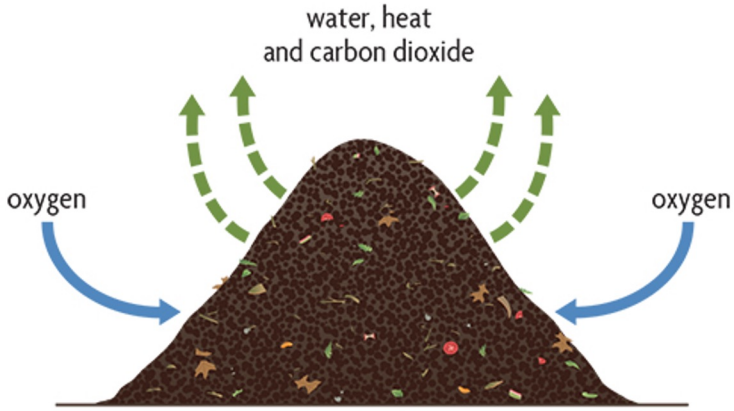
How often is up for debate…

- Set schedule
- Temp dependant (too cold/hot)

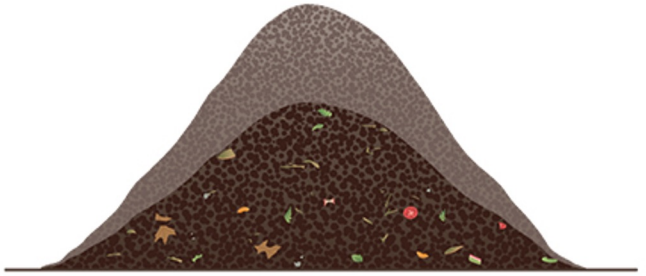


Compost mixes need a mixture of sizes

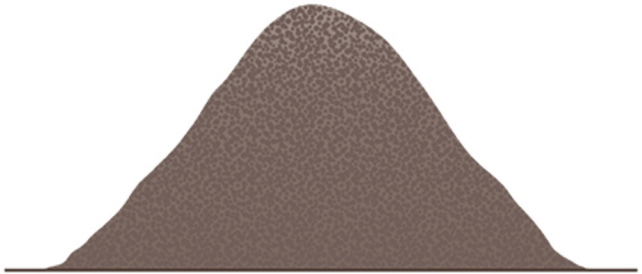




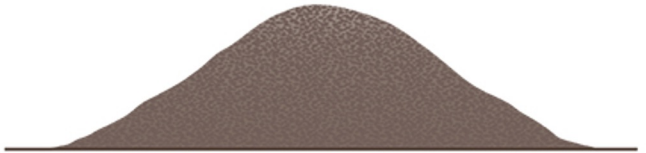
a) Early stage of composting
(pile about 5 feet tall by 8 to 10 feet at base)



b) During first turning
(covering now inside and partially composted material used on top and sides)

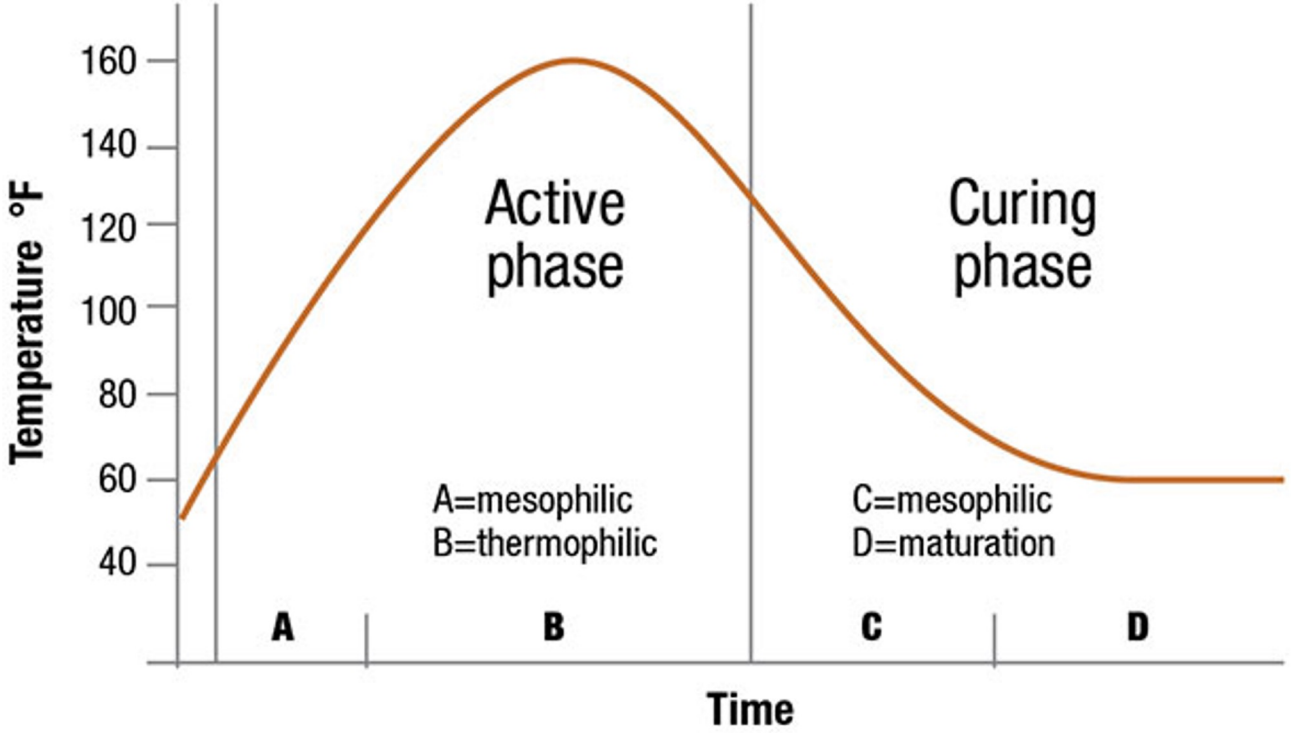


c) After first turning
(pile covered with composted material)



d) Composting finished
(pile smaller than original size)

FIGURE 1 Temperature changes in an average compost pile



When is it done?

Earthy, sweeter smell

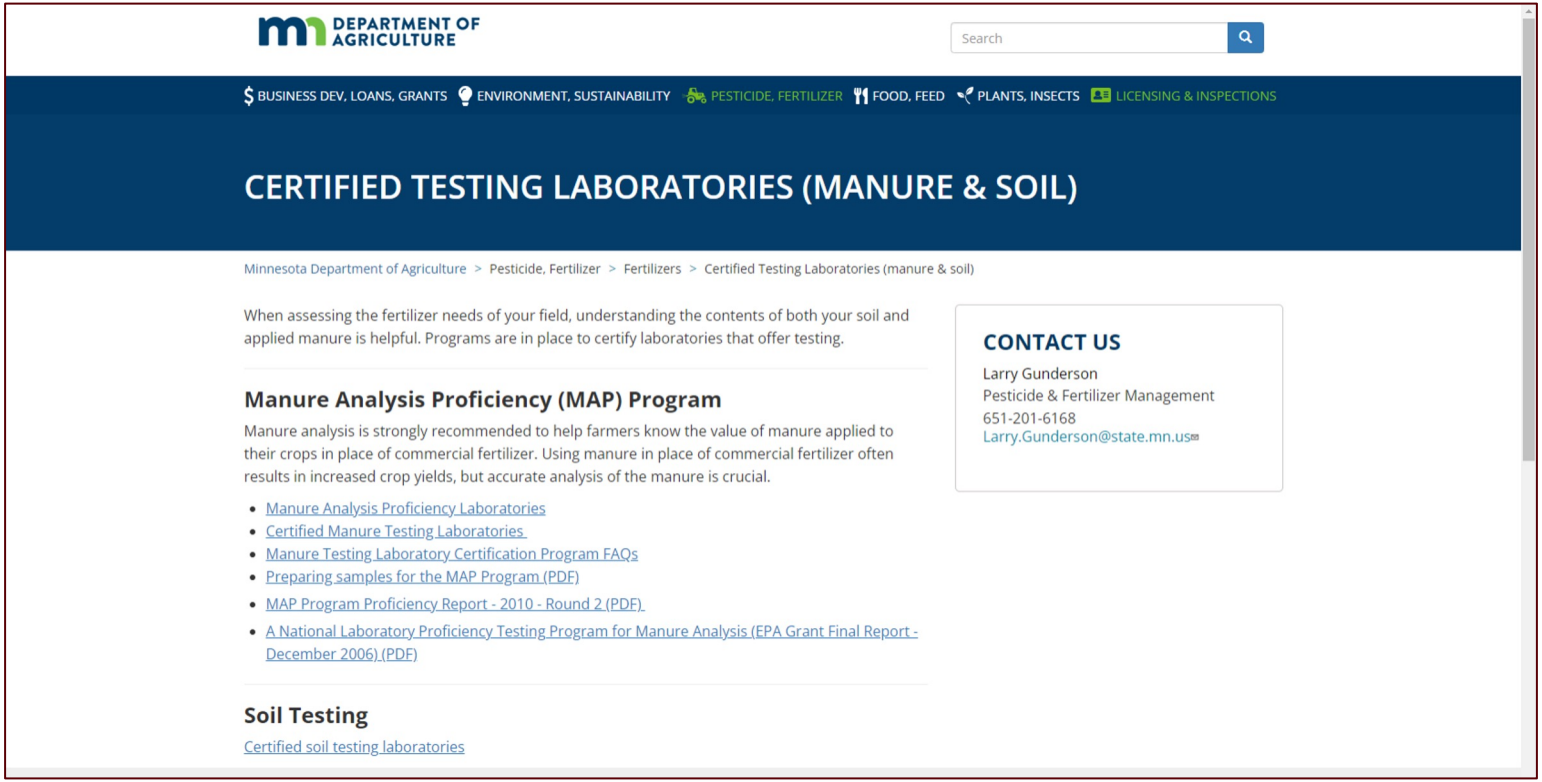
Resembles soil/fine mulch

Hard to ID compost elements

No more heat is generated

Hopefully 2 to 6 months (variable)

Testing Compost



A note on weed and disease control…

Composting microbes range = 55 to 150 degrees F

Weed seed deaths = 140 degrees F

Tough diseases/nematode deaths = 140-150+ degrees F

"Good" compost needs at least 131F (55 C) for 3+ days.

Have backup strategies!

Diseases Specific to Hops

Verticillium wilt

- *V. dahliae* = 122 F for 3 days
- *V. albo-atrum* = 113 F for 8 hours

Hop powdery mildew = ?

Citrus bark cracking viroid

- 158 F for 24 hours

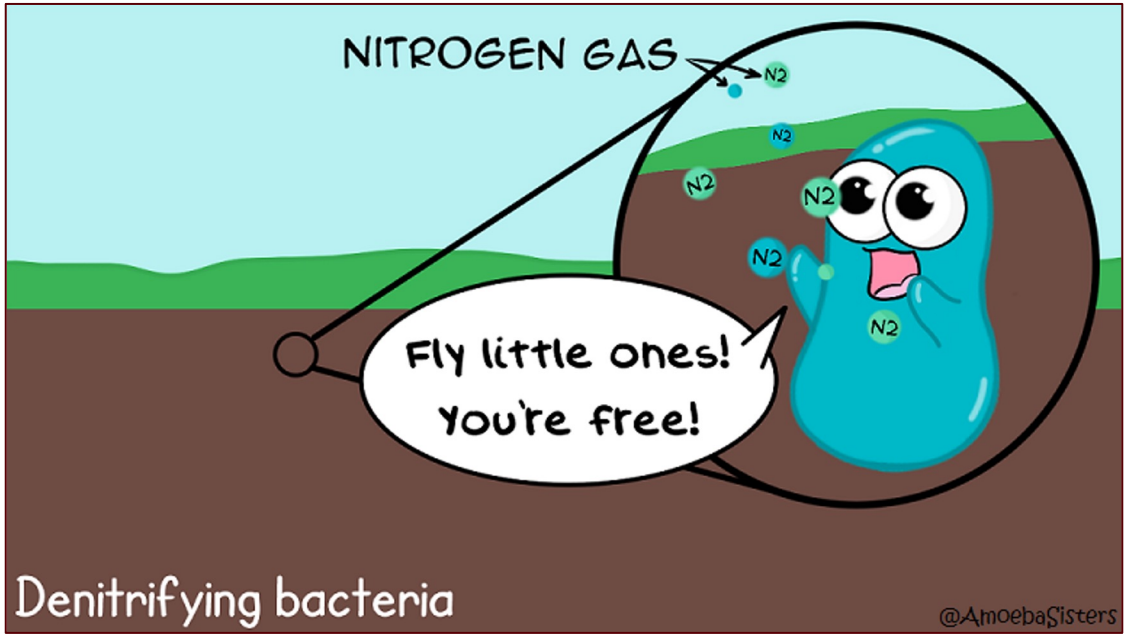
Hop downy mildew = ? (flame treatment used)

How to lose (more) nitrogen with composting…

Way too wet
- Denitrification
- Nitrate leaching

Too high pH
- Ash, lime, etc.
- Ammonia gas

Not enough C
- All pathways



Bin Designs and Space Considerations

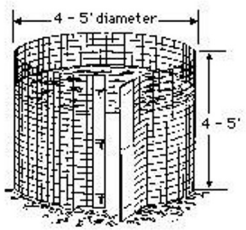
LOTS of possible types

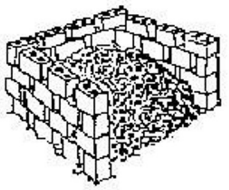
Access to water and feedstock

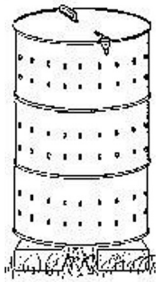
Aim for 3 to 5’ for all dimensions

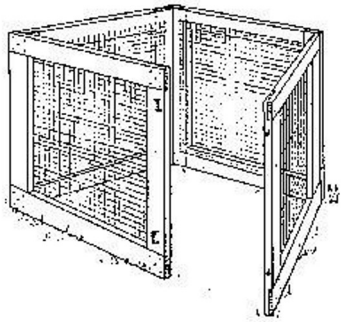
No “infinite” sized piles

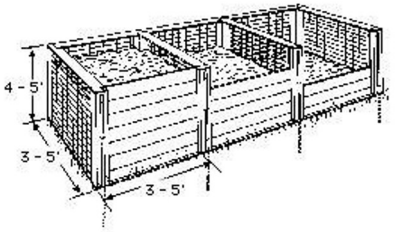
Roofing can help a lot



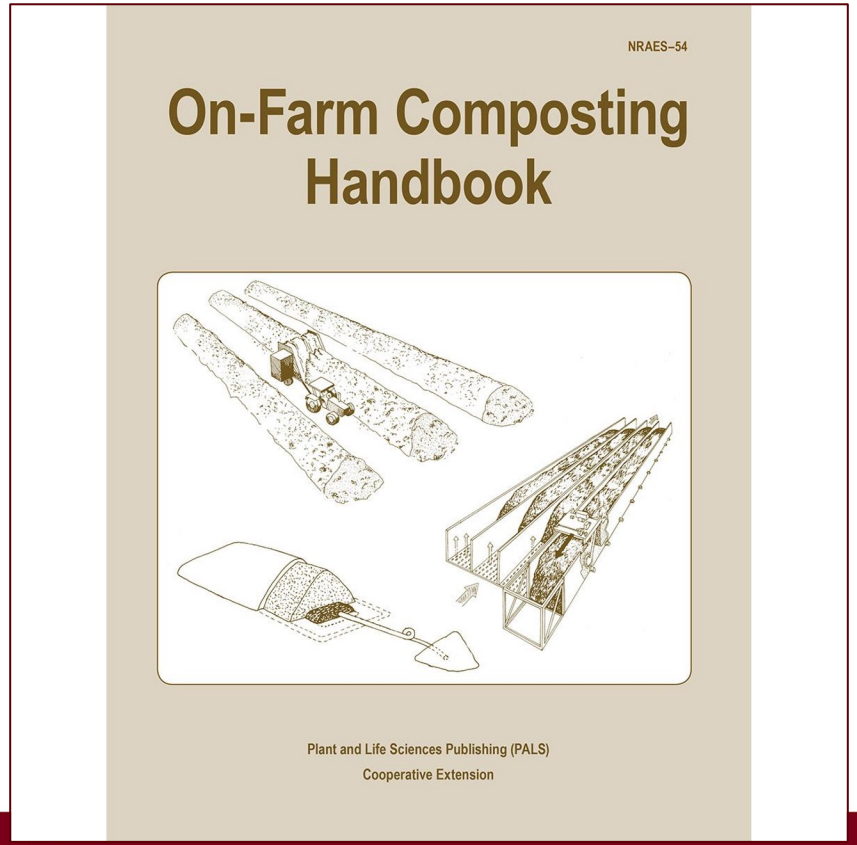








Resource for Larger Compost Designs



Windrow Composting

Static Aerated Piles

Passive static pile

Johnson-Su Bioreactor

Active static pile

Structures

Compost Application on Perennial Systems

Elbow grease method

Manure spreader

Mulch spreader

Others?

Hop Composting Research Roundup

On-Farm Composting of Hop Plant Green Waste—Chemical and Biological Value of Compost

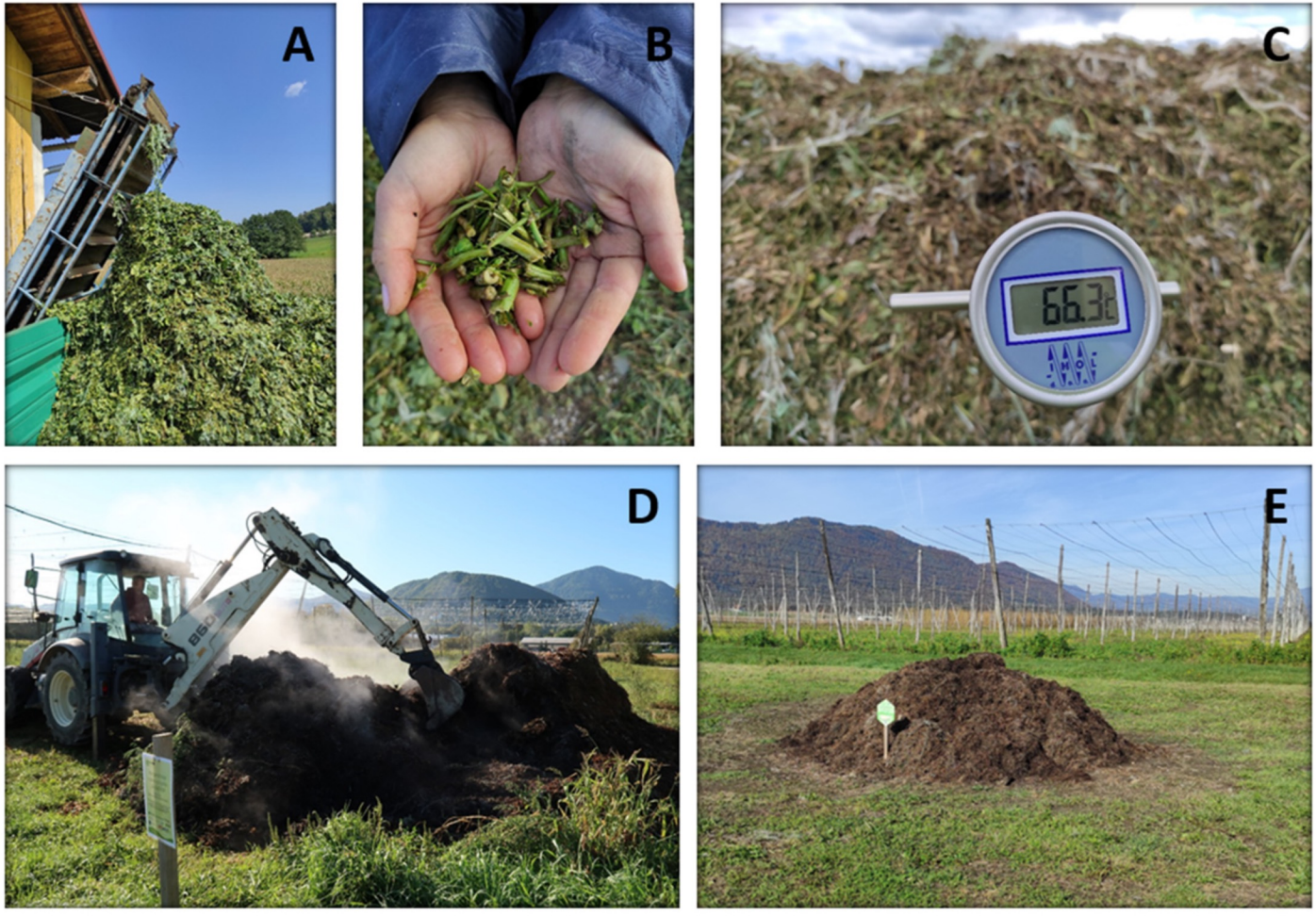
Took place near Zalec, Slovenia

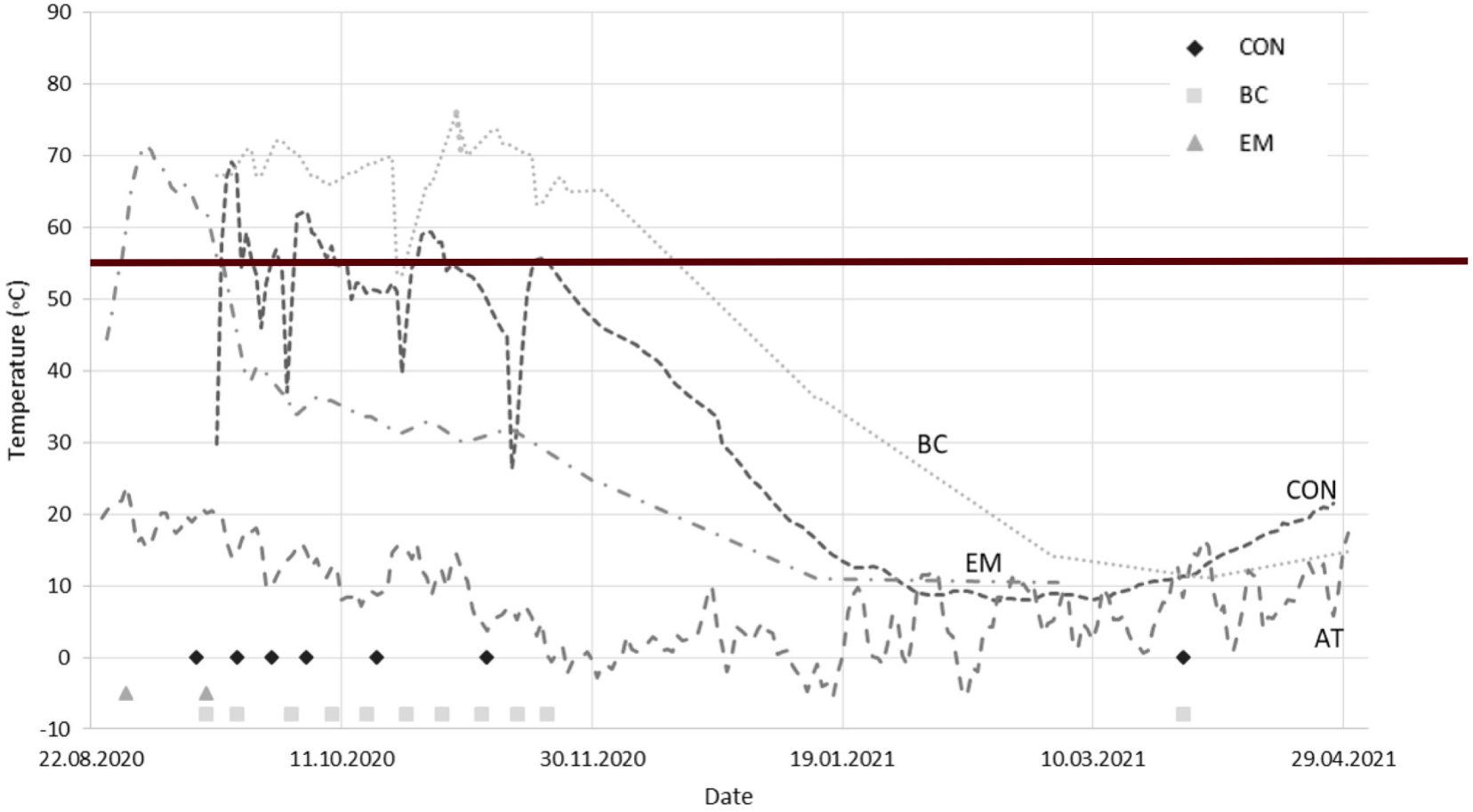
Treatments

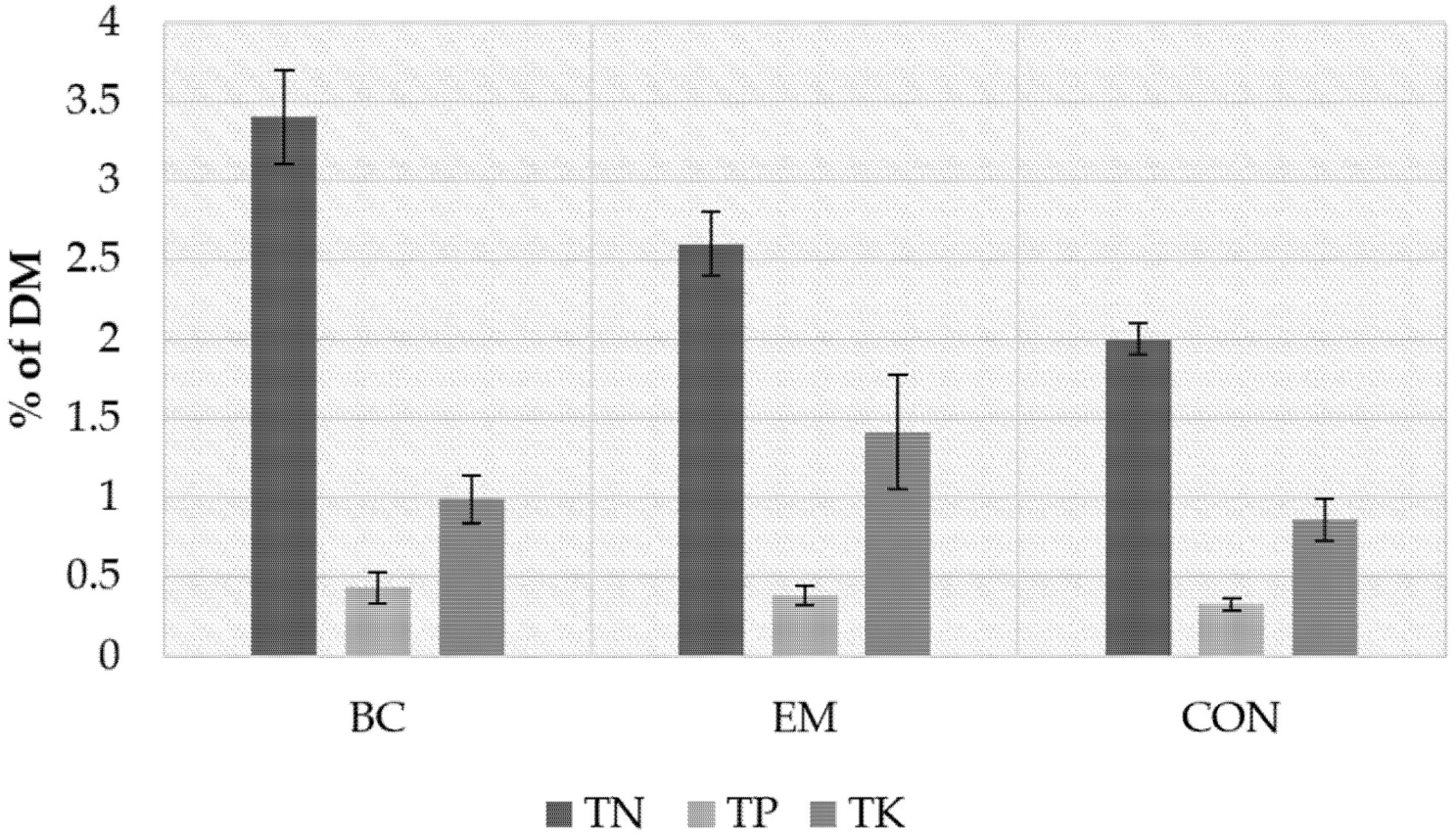
- Hop only compost (CON)
- Hop compost plus 4% biochar (BC)
- Fermented hop “compost” (EM)

All treatments seemed to work well

- EM and BC lost less N (multiple reasons)







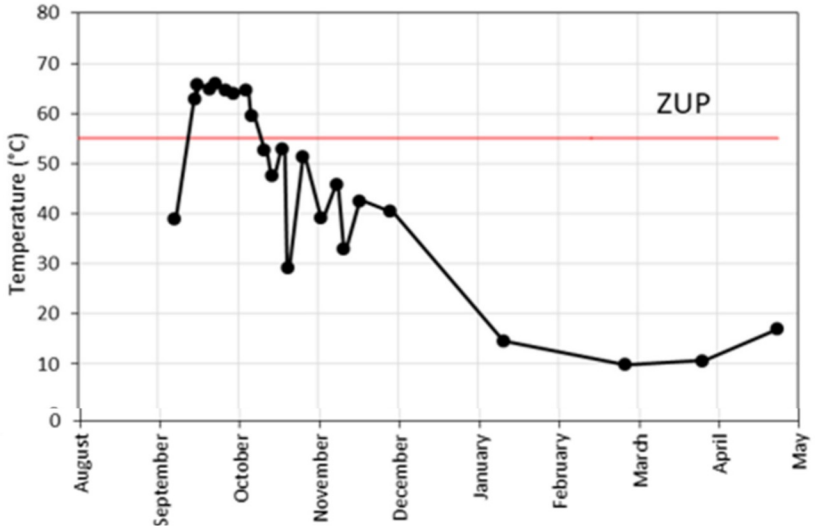
The Quantity and Composition of Leachate from Hop Plant Biomass during Composting Process

Turned 7 times (temp based)

- Hop leaves, stems, twine
- about 6.5 feet tall

Temperature needs met

- 55 C (131 F) for 14 days
- Slovenia



Consider covering during curing

Recycling nutrient-rich hop leaves by composting with wheat straw and farmyard manure in suitable mixtures

Compost mixtures that worked

- 2:1 hop leaves to straw (unchopped?!)
- 1:1 hop leaves to cow manure

Finished within 9 months

- Good C:N ratio
- Hit temp requirements (Portugal)

Hop stem ash led to N release

Composts Obtained by Mixing Hop Leaves with Wheat Straw or Farmyard Manure Improved Soil Properties and Increased Microbial Communities

Hop compost added to lettuce

- 2 harvest cycles

Straw/hop mixture

- More microbes than manure
- But manure was very “aged”

Lettuce grew well w/ all treatments

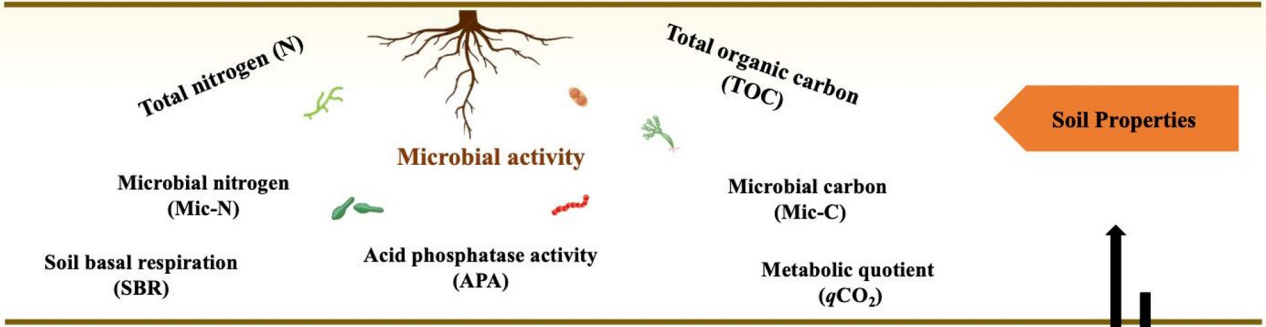
- Was not phytotoxic

Compost mixtures Ratio

Hop leaves + Cow manure (HM)
1:5; 1:3; 1:1
Hop leaves + Straw (HS)
1:2; 1:1; 2:1
Hop leaves + Straw manure + Hop stems ash (HSA)
1:1:0.04

D1: 20 t dry weight ha^{-1} **D2**: 40 dry weight ha^{-1}	**Two growing cycles**

Hop Leaves-Based Compost → **Soil Organic Amendment** → **Lettuce Growth**



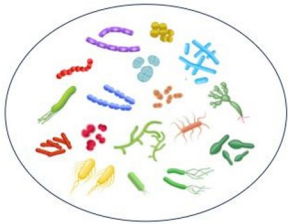
Soil Properties

SOIL

Soil Microbial Composition

DNA EXTRACTION

Microbial Diversity/Density



CONCLUSIONS:

Hop leaves-based compost, particularly those with a higher proportion of leaves and straw, provided a high availability of N and C, which greatly influenced soil composition, shaping the soil microbial community, ultimately enhancing soil N availability for plant development.

Some takeaways…

Hop residue composts well
- Recipes not complicated
- Higher N content product

Disease issues => major caution
- Lack of research

Can you get it done in time?
- Winter is coming!

Thank you!