

The Fate of Elm Diseases in a Municipal Composting Environment



Compost Matters
March 2010

PRESENTATION OVERVIEW

- ➔ Project Background & Objectives
- ➔ Procedures – Inoculation
Experiments and Composting
Trials
- ➔ Composting Trials - Results
- ➔ Summary and Recommendations



BACKGROUND - PROJECT IMPETUS

- ➔ Edmonton's Parks Branch (Forestry Unit) provides wood to the Gore composter
- ➔ Diseased wood from Forestry is diverted to landfill
 - Reduces risk of disease spread
 - Parks Branch is a major consumer of Gore



BACKGROUND - PROJECT IMPETUS

- ➔ There are other contributors of wood to the Gore process
 - Not necessarily screened
- ➔ Need to determine the fate of some common local plant diseases during composting
- ➔ Possibility of diverting a portion of Forestry's diseased wood from the landfill.



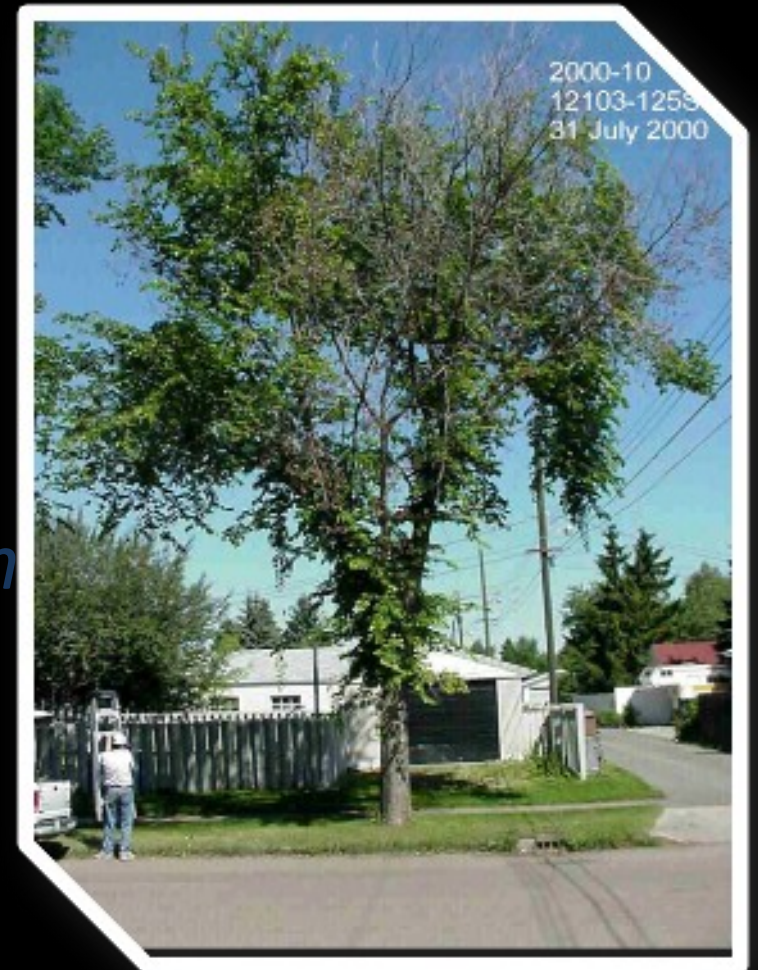
BACKGROUND - SOME COMMON DISEASES

→ *Dothiorella ulmi*

- *D. ulmi*-infected elm makes up the majority of landfilled wood

→ *Verticillium dahliae* and *V. albo-atrum*

- Have been isolated from elm in Edmonton area
- Have wide host ranges



LITERATURE REVIEW

- ➔ Plant pathogens can be inactivated by exposure to heat
 - Heat tolerance varies by organism and form
 - No time-temperature guidelines for plant pathogens in North America
 - Human pathogens: 55°C for 3 days
- ➔ Fungi and fungi-like species
 - Some species survived $T > 55^{\circ}\text{C}$



LITERATURE REVIEW

➔ *Verticillium dahliae*

- Eliminated in small-scale composter when material turned, $T_{\max} \approx 70^{\circ}\text{C}$, and $T > 50^{\circ}\text{C}$ for 10-14 days

➔ *V. albo-atrum* & *Dothiorella ulmi*

- Nothing in the literature
- *D. ulmi* laboratory incubation tests suggest typical composting temperatures should be adequate



SPECIFIC OBJECTIVES

- ➔ Determine to what degree *D. ulmi*, *V. dahliae*, and *V. albo-atrum* are inactivated by time-temperature conditions in Gore composter.
 - How likely is it that these organisms will be eradicated in the Gore composter?
 - Does diseased wood need to be diverted from the composter?

OVERALL EXPERIMENTAL PLAN

- ➔ Wood chip inoculation experiments
- ➔ Place bagged infected wood chips in the Gore system during the high-temperature phase
- ➔ Periodically recover bags and evaluate pathogen survival in composted elm wood



PROCEDURES - WOOD CHIP INOCULATION

- ➔ Wood chip inoculation procedure optimized
 - Inoculum prepared from fungal cultures
 - Wood chips sterilized by autoclaving, then sprayed with inoculum and agar plugs placed
 - Incubated for 26 days at 22°C



Control

Dothiorella ulmi



Verticillium dahliae

*Verticillium
albo-atrum*

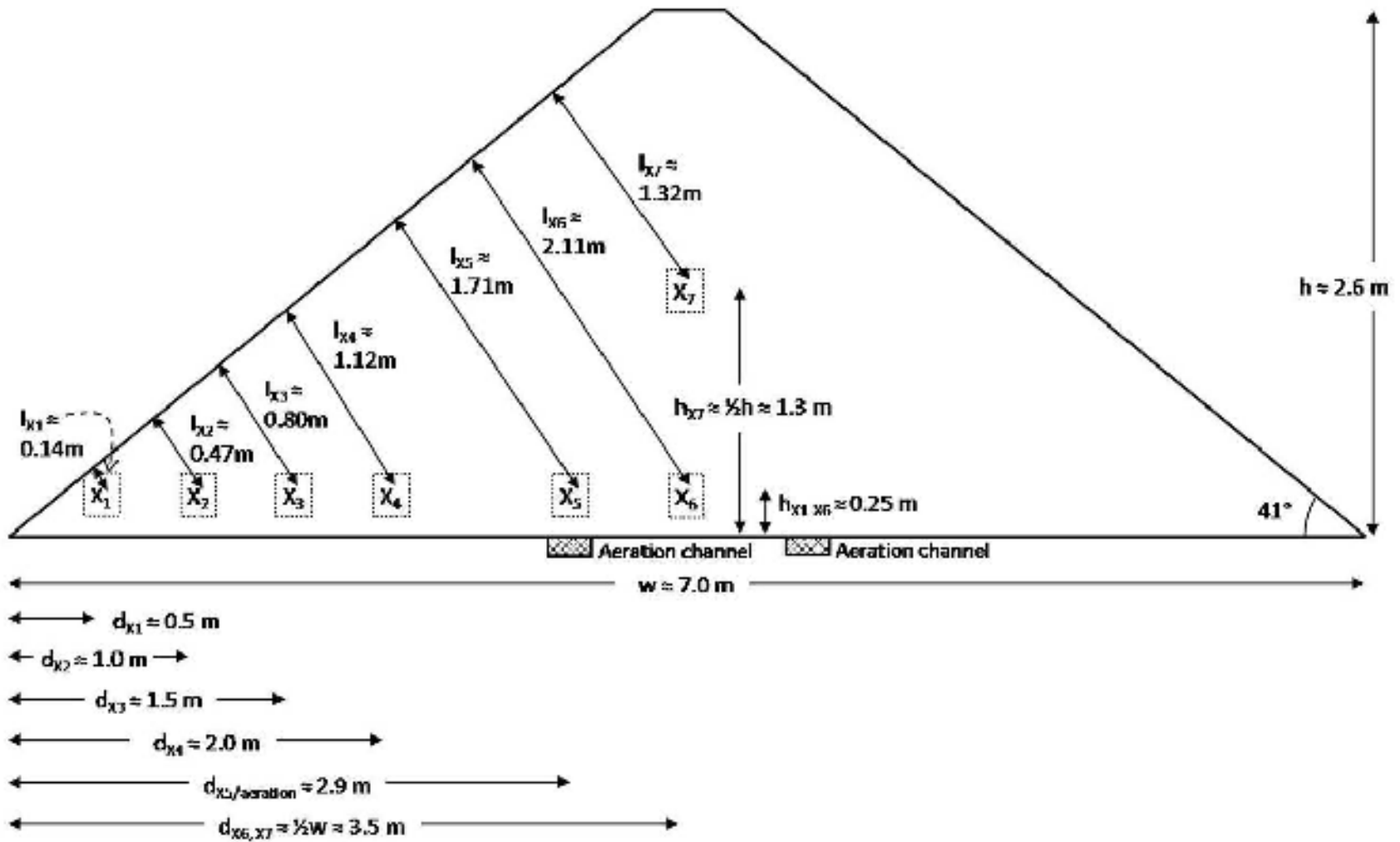


PROCEDURES - SAMPLE PREPARATION

- ➔ Infested wood chips sealed in sterilized Ziploc bags (with air space).
 - Organisms affected by temperature only.
- ➔ Ziplocs placed into nylon mesh bags
- ➔ “Sample bundles” created
 - One bag for each organism, plus a temperature probe.



PROCEDURES - SAMPLE PLACEMENT



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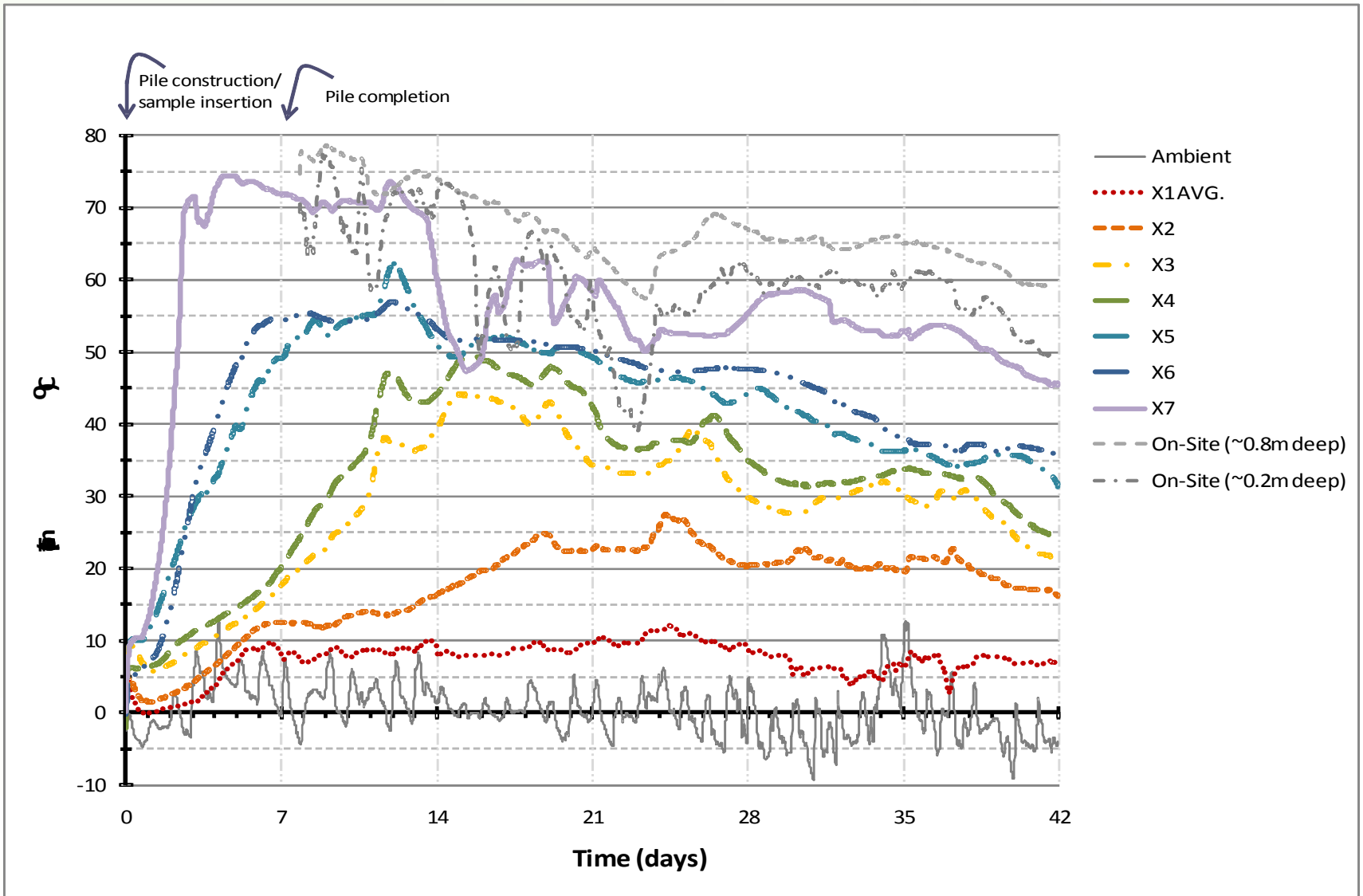


(October 13 2009)

PROCEDURES - SAMPLE COLLECTION AND TESTING

- ➔ Sample bundles and compost samples collected periodically
 - Every day or two for first week, and weekly or biweekly thereafter.
- ➔ Wood chips tested for pathogen survival
- ➔ Compost samples tested for:
 - Moisture content (MC)
 - pH
 - C:N ratio

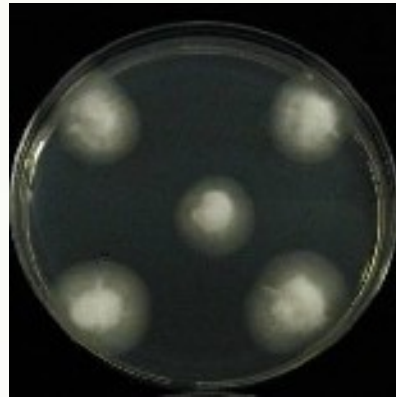
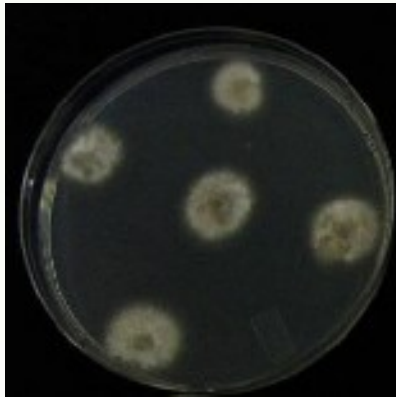
RESULTS - TEMPERATURE



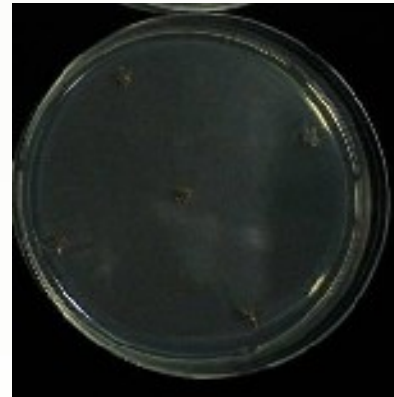
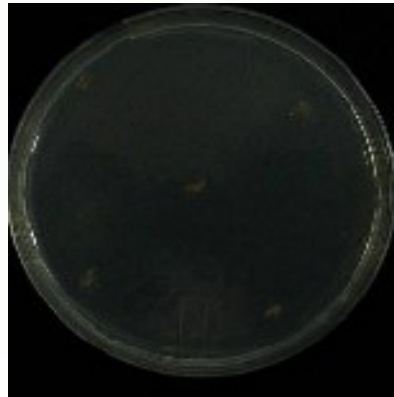
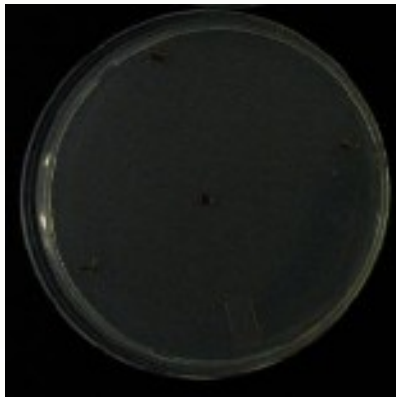
RESULTS - PATHOGEN SURVIVAL VS. TEMPERATURE

		Sample Location						
		X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₇
Total amount of time (days) that various temperatures were exceeded	≥ 70 °C	0	0	0	0	0	0	8.7
	≥ 65 °C	0	0	0	0	0	0	11.2
	≥ 60 °C	0	0	0	0	0.8	0	13.7
	≥ 55 °C	0	0	0	0	2.6	3.2	21.5
	≥ 50 °C	0	0	0	0	12.3	16.0	35.6
	≥ 45 °C	0	0	0	7.1	20.3	26.5	39.7
	≥ 40 °C	0	0	5.5	11.1	26.1	30.0	39.9
	≥ 35 °C	0	0	11.7	17.6	34.4	38.5	40.0
	≥ 30 °C	0	0	21.3	30.1	38.6	38.9	40.1
Pathogen survival at end of composting	<i>D. ulmi</i>	+	+	-	-	-	-	-
	<i>V. albo-atrum</i>	+	+	-	-	-	-	-
	<i>V. dahliae</i>	+	+	-	-	-	-	-

RESULTS - PATHOGEN SURVIVAL



X₂, Day 42



X₇, Day 42

D. ulmi

V. dahliae

V. albo-atrum

RESULTS - PATHOGEN SURVIVAL VS. TEMPERATURE

- ➔ Bags at locations where pathogen destruction was seen were compressed.
- ➔ Testing was done at room temperature in compressed (anoxic) bags
 - Pathogens survived anoxic conditions



CONCLUSIONS

- ➔ Appears that *D. ulmi*, *V. albo-atrum*, and *V. dahliae* will be inactivated if temperatures exceed 40°C for more than 5.5 days.
 - Likely to occur in interior of pile; perhaps not in outer layer.
 - Important to ensure that all materials from exterior zones in Stage 1 get mixed into higher temperature zones in subsequent stages.
- ➔ May not need to divert diseased wood to landfill.

RECOMMENDATIONS

- ➔ Repeat trial 2x more, with modifications to improve procedures, e.g.
 - Better sorting of wood chips
 - Use of rigid sample containers
- ➔ Study temperature profiles in Gore Stages 2 and 3 (curing) in detail
- ➔ Potential small-scale reactor study
 - Pinpoint time-temperature requirements
 - Determine suitable indicator organisms

ACKNOWLEDGEMENTS



PROJECT OVERVIEW

➔ Goal:

- To determine whether or not elm diseases are destroyed during composting

➔ Implication:

- Determine whether or not diseased wood must be kept out of compost feedstocks



RESULTS - COMPOST

- ➔ Pathogen survival not affected directly by MC, pH, or C:N
- ➔ MC : ~53% to ~62% at start
~32% to 55% at end
- ➔ pH : ~7.6 to ~7.8 at start
~7.3 to ~8.4 at end
- ➔ C:N: varied throughout pile at start and end