WASTEWATER CHARACTERIZATION IN TOMATO PACKINGHOUSES

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OUTLINE

- Background: Water Use and Wastewater Generation
- Study Objective
- Methods
- Results:
  - Chemical constituents of concern in wastewater
  - Evolution of metals in wastewater
  - Likely sources of metals in wastewater
- Summary/concluding thoughts

TOMATO PACKING: JOURNEY FROM FIELD TO PACKINGHOUSE

Harvested Sanitized Packed

Dump Tank Water:

Water usage for round tomato: 3,000 to 22,000 gallons/day.
Water usage for roma and grape tomato: 70 to 25,000 gallons/day.

Other Water (Washing/Cleaning operations):

Water requiring disposal: 50 to 4,800 gallons/day.

Source: Steve Sargent *Options for Utilization of Tomato Packinghouse Solid Waste and Water.*

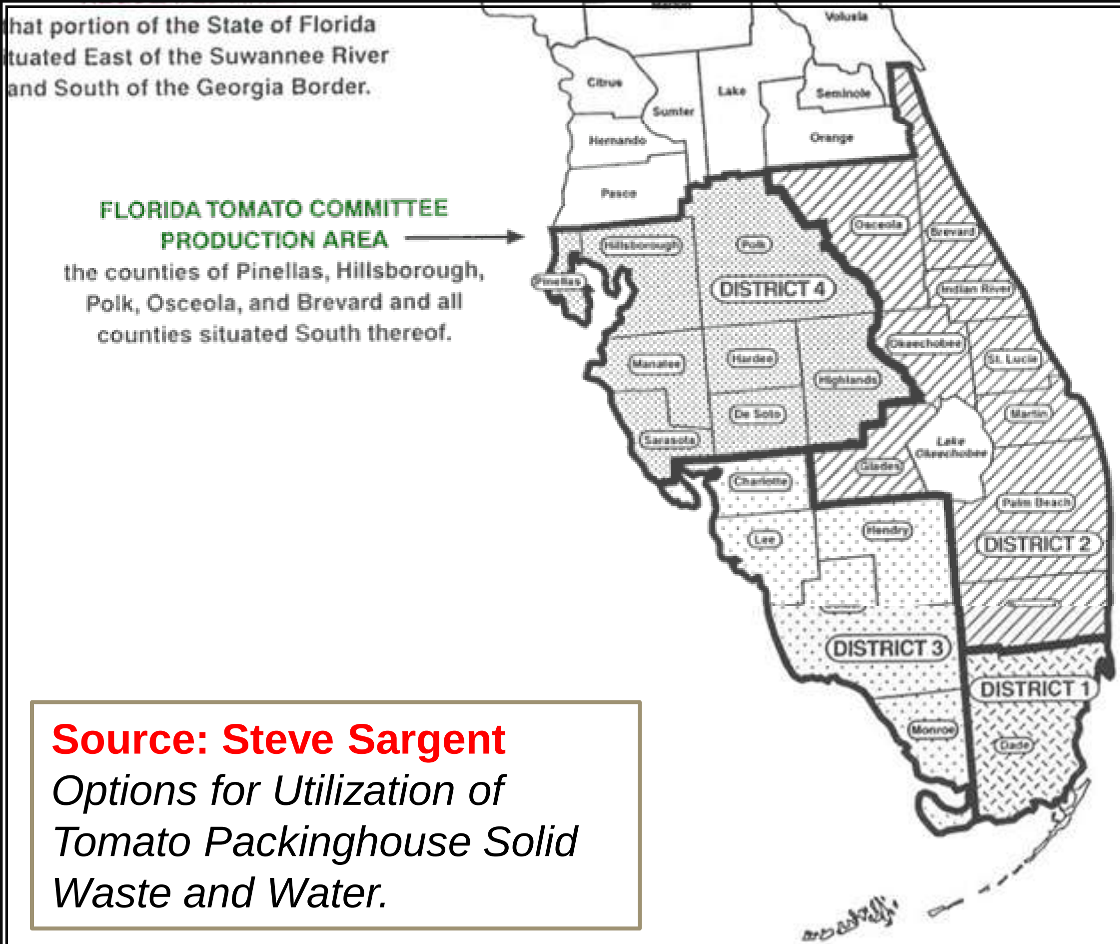
WASTEWATER GENERATION

- Clean water (and Chlorine) is added in dump tanks

- Tomatoes are washed with this water all day

- Wastewater is generated

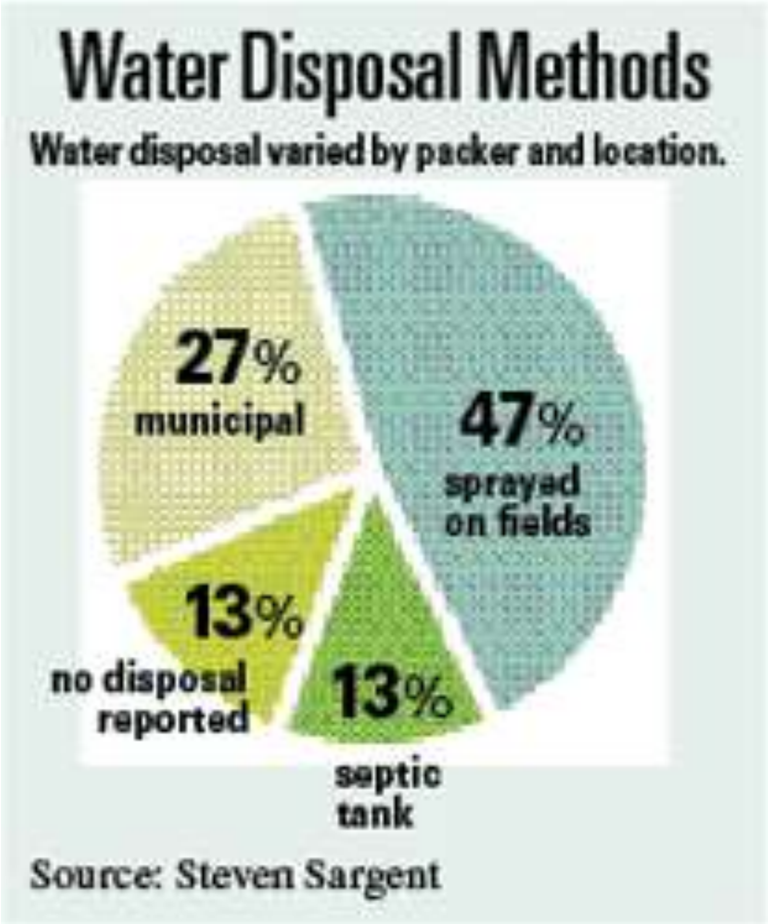
AMOUNTS OF WASTEWATER



Source: Steve Sargent
Options for Utilization of Tomato Packinghouse Solid Waste and Water.

Total amount of water requiring disposal:
31.3 million gallons per season.

District	Total water/season (gal)	Use	Disposal cost
1	3,068,968	50% sewage & 50% sewage/ filtration	no report
2	597,800	100% sewer	no report
3	8,624,000	50% spray field & 50% spray field /sewage	$9,000 season
4	18,981,200	83% spray field & 17% septic service	$144,400 season
TOTAL	**31,271,968**		$154,600



American Vegetable Grower. August 2008. Reducing Disposal Costs. http://www.growingproduce.com/americanvegetablegrower/?storyid=282&style=1

Greatest Reported Concerns:

- Need approved locations for all discharge items
- Disposal cost
- Pending regulations will change business.
  - EPA's New Rules [Numeric Nutrient Criteria]

- **What is present in wastewater?**
- **Can wastewater be discharged in surface water/municipal systems?**

SUMMARY OF METHODS

WASTEWATER SAMPLE COLLECTION:

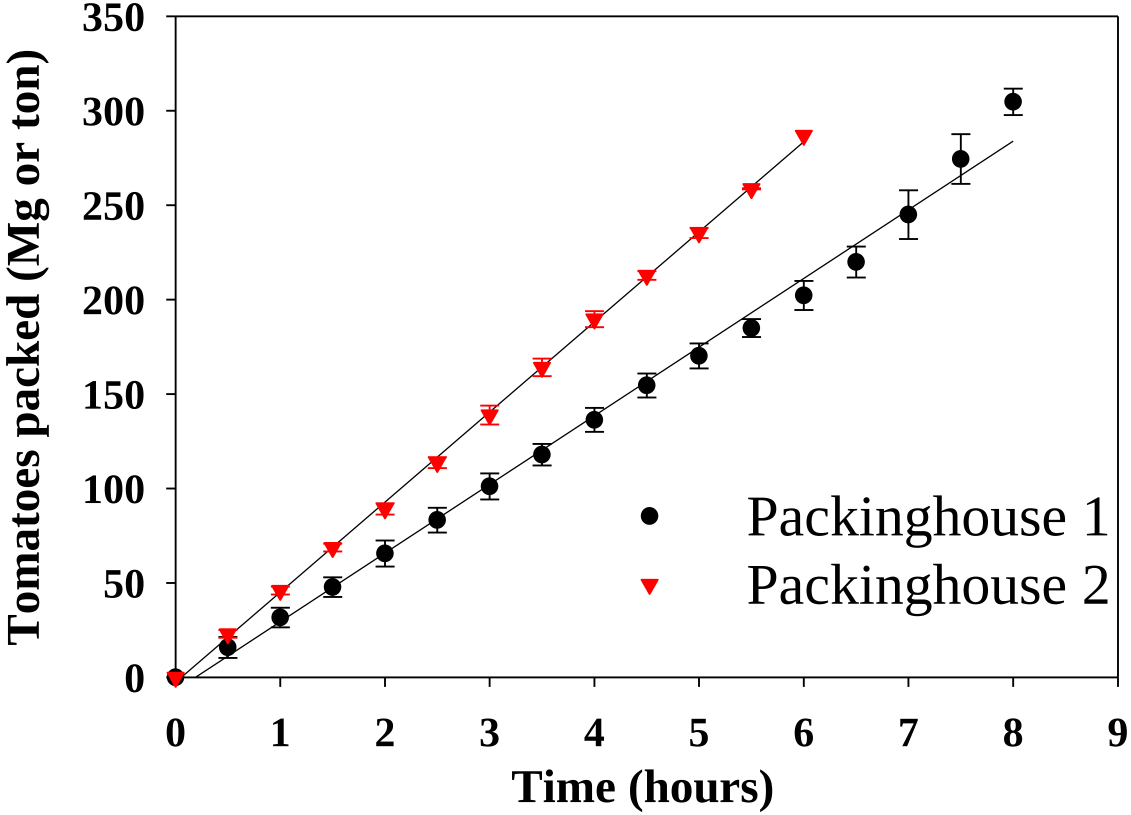
- **Two tomato packinghouses; Four sampling events in each packinghouse.**
- **Samples collected from dump tanks before beginning of packing operations and then continuously after the start of packing operation at 30-minute intervals for about 6−8 hours.**

ANALYSES:

- **Samples analyzed for pH, EC (salinity), chloride**
- **19 metals**
  - 11 metals not present (Al, As, B, Cd, Co, Cr, Mo, Mn, Ni, Pb, and Se)
  - **Only 8 metals were present (P, Ca, Mg, K, Na, Cu, Zn, Fe)**

RESULTS

AMOUNTS OF TOMATOES PACKED



- PKG 1: Packing rate (Roma): 38 tons/hour. Rate of tomato addition: **55-72 seconds** per 1000 lbs (~0.5 ton). Tomato stayed in dump tanks longer.
- PKG 2: packing rate (round): 48 tons/hour. Rate of tomato addition: **29-40 seconds** for 1000 lbs (~0.5 ton). Tomato stayed in dump tanks for less time.

WASTEWATER CHARACTERISTICS

Properties of municipal water used in the dump tanks before packing (time = 0 hours).

PKG	pH	EC	Chloride
		dS m^{-1}	mg L^{-1}
1	7.2	**0.43**	**27**
2	7.1	**0.38**	**27**

Properties of wastewater generated in the dump tanks at end of packing (time = 6-8 hours).

PKG	pH	EC	Chloride
		dS m^{-1}	mg L^{-1}
1	6.6	**2.8**	**1125**
2	7.1	**1.3**	**255**

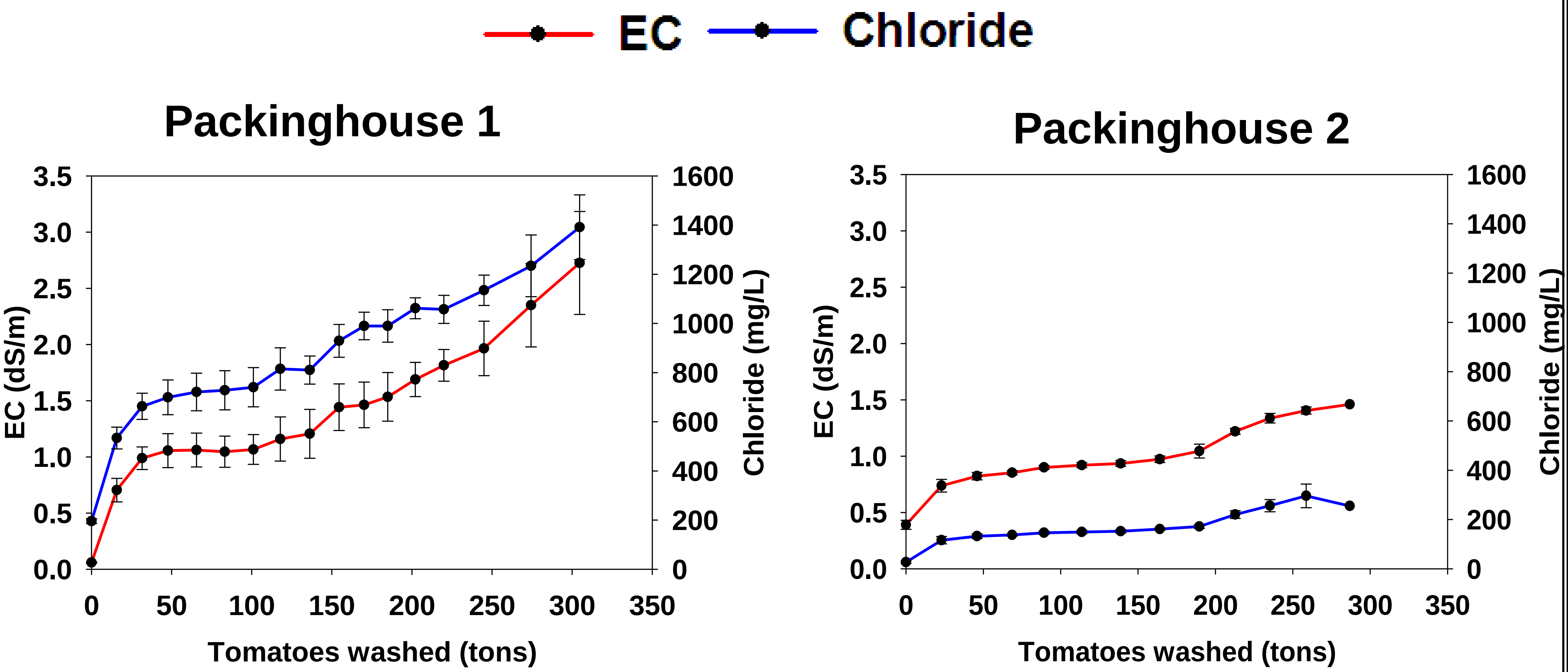
- **Greater chloride in wastewater was due to the use of sanitizers (chlorine gas, chlorine dioxide) to kill pathogens**
- **Chloride and EC were significantly correlated (r=0.95)**
- **Lower chloride in PKG2 was because of automated control than PKG1 where it was manually maintained**

PHOSPHORUS AND TRACE METALS IN WASTEWATER

Parameters	Packinghouse 1		Packinghouse 2	
mg/L	Water	Wastewater	Water	Wastewater
P	0.27	5.7	0.21	2.8
Cu	0.01	2.2	0.01	1.9
Zn	0.13	0.3	0.11	0.1
Ca	34	59	34	55
Mg	16	25	15	21
K	6	49	6	24
Fe	0.02	0.8	0.02	0.1

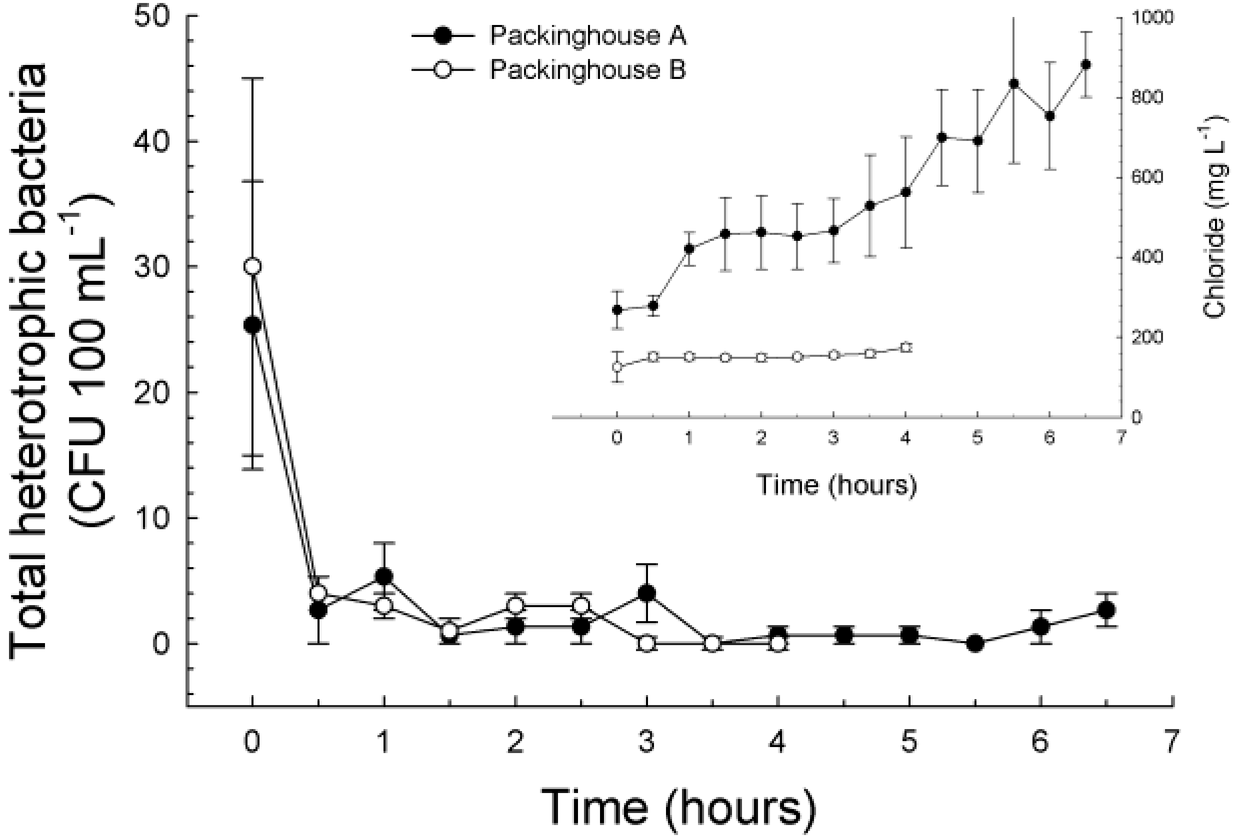
- Greatest increase in P and Cu concentrations in wastewater; these were above the surface water quality standards

EFFECT OF AMOUNT OF TOMATOES WASHED ON WASTEWATER QUALITY



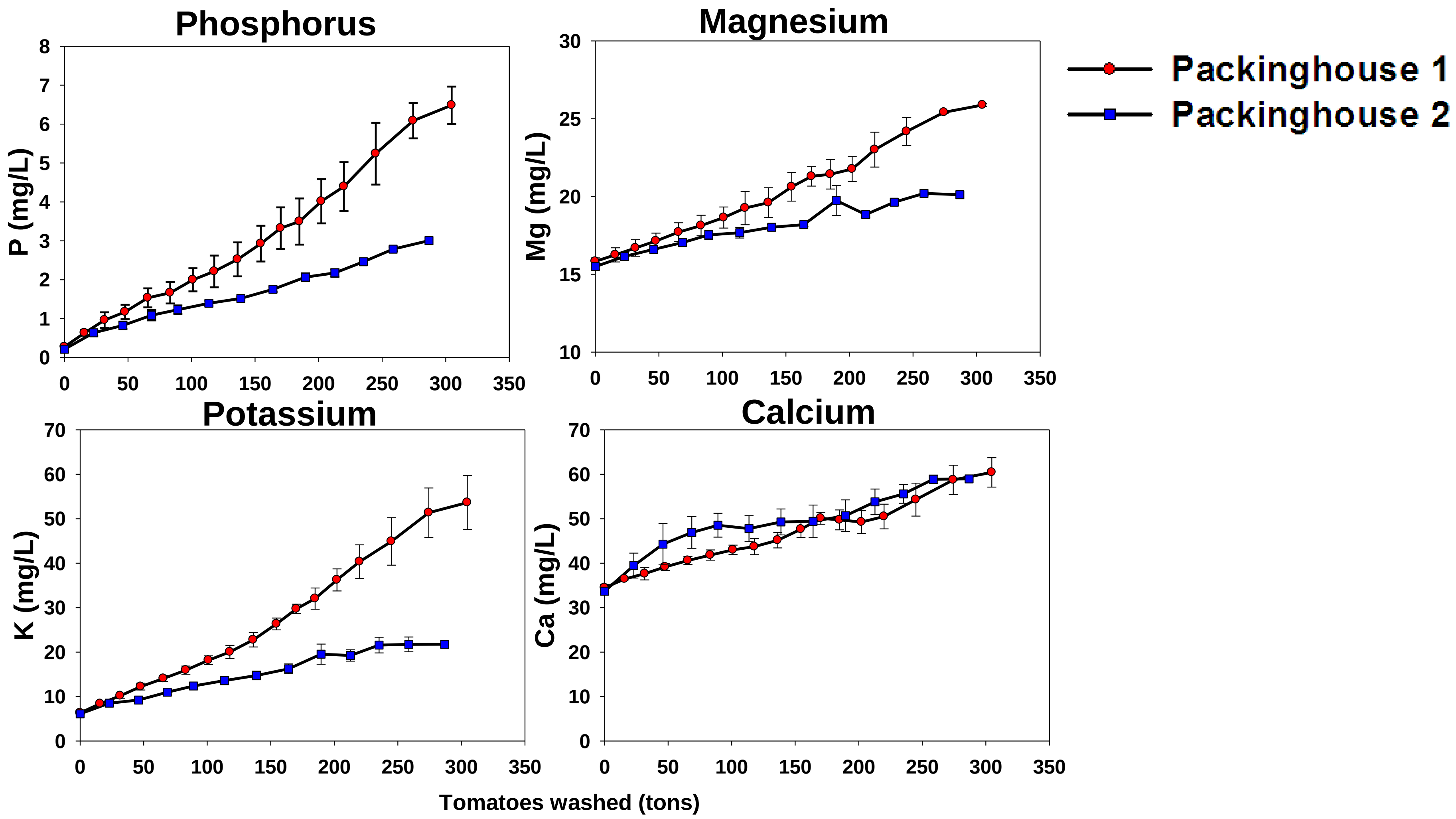
- EC and chloride increased linearly with washing of tomatoes with higher magnitude in PKG 1 than PKG 2.

Data from Bonilla and Toor (2009). Tomato Institute Proceedings.



- **Concentrations of bacteria were very low in all dump tank samples.**
- **None of the samples were positive for *Salmonella spp. or E. coli O157:H7.***

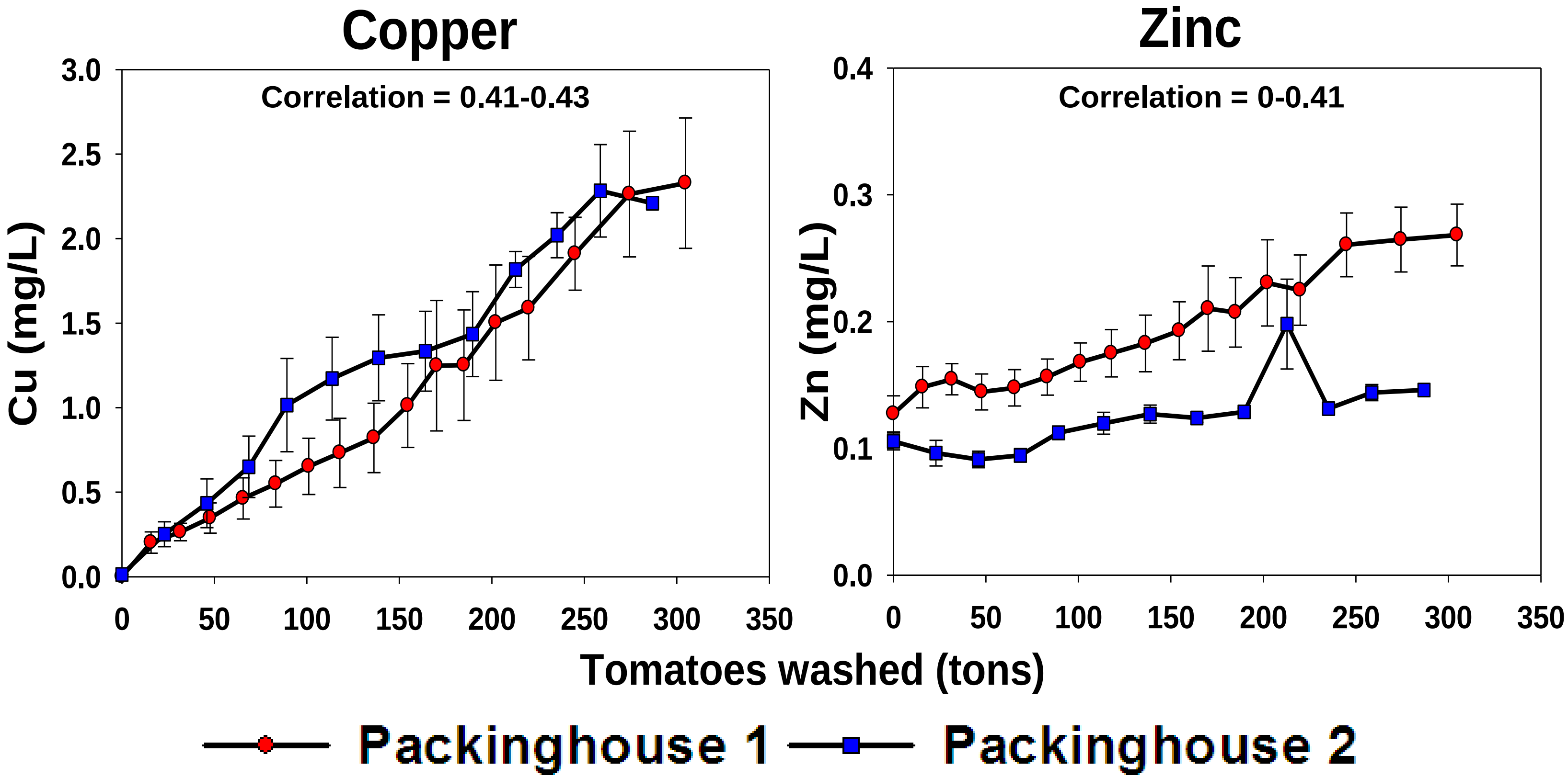
EVOLUTION OF PHOSPHORUS AND CATIONS IN WASTEWATER



❖ **P and cations increased linearly with the washing of tomatoes**

❖ **Concentrations of all elements were higher in PKG 1 than PKG 2**

EVOLUTION OF COPPER AND ZINC IN WASTEWATER



- Copper increased linearly with the washing of tomatoes.
- Zinc increased more in PKG 1 than PKG 2.

IMPORTANCE OF CONTACT TIME OF TOMATOES WITH DUMP TANK WATER

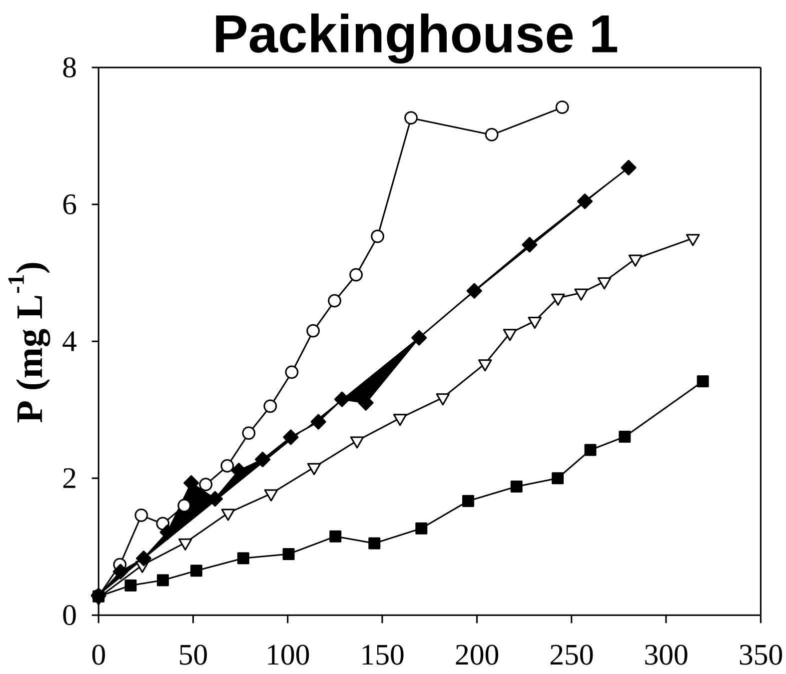
	Packing rate	Rate of tomato addition	Remarks
PKG 1	38 tons/hour	55-72 seconds/1000 lbs	**More interaction of tomatoes with dump tank water**
PKG 2	48 tons/hour	29-40 seconds/1000 lbs	Less interaction of tomatoes with dump tank water

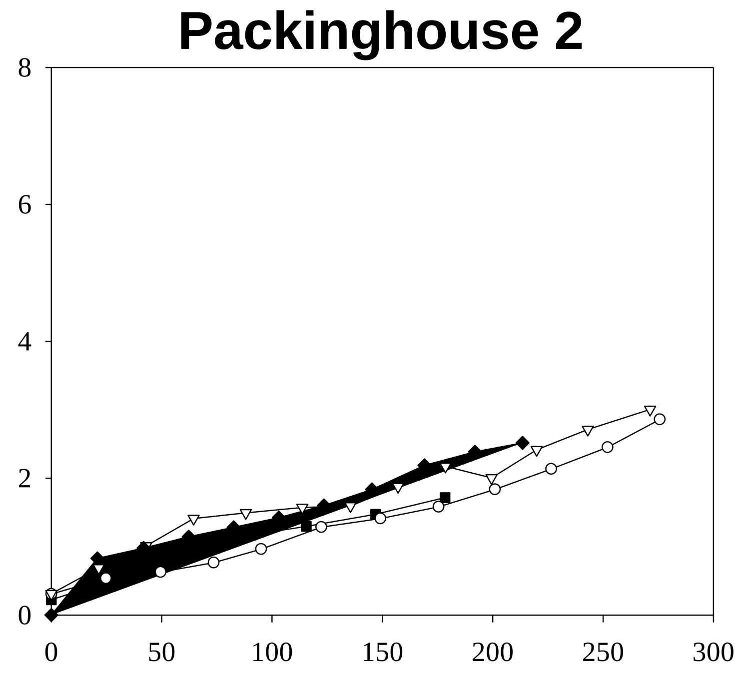
LIKELY SOURCES OF P AND CU IN WASTEWATER?

- **External factors: residues on tomatoes, plant debris?**

	Source	Purpose	Days to harvest
P	Organo-P insecticides- a) Dimethoate b) Malathion c) Methadiphos	Control insects like aphids, drosophila, mites, earthworms, leaf miners, whiteflies	1−7
	Fungicides Mono and di-K salts of phosphorus acid	Powdery mildew, Phytopthora, Pythium species	1
Cu	Fungicides; Copper hydroxide	Anthracnose, early blight, late blight	1−2
	Micronutrients-foliar spray; Copper sulfate	Cu deficiency in plant tissue (<5 mg kg^{-1}) on dry wt. basis	-

- **Internal factors: wastewater chemistry, especially high chloride may scour damaged culls and release soluble P from tomatoes?**





	Step	Packinghouse 1			Packinghouse 2		
		Equation	R^2	P value	Equation	R^2	P value
P	1	0.75 + 0.015 t	0.53	<0.05	0.37 + 0.009 t	0.92	<0.05
	2	-0.49 + 0.004 Cl + 0.01 t	0.76	<0.05	0.24 + 0.002 Cl + 0.007 t	0.92	<0.05
Cu	1	-0.0008 + 0.0074 t	0.72	<0.05	0.11 + 0.008 t	0.76	<0.05
	3	-0.22 + 0.00006 Cl + 0.006t	0.76	<0.05	-0.11 + 0.003 Cl + 0.005 t	0.77	<0.05

- **In addition to tomatoes, chloride can affect the concentration of P.**

SUMMARY

- Chloride, P, and Cu elevated in wastewater.
- High chloride in wastewater due to reaction of chlorine sanitizers with water (hydrolysis). Increase in chloride increased EC in wastewater.
- Dechlorination may be needed if Chloride levels are higher in wastewater (~>160-200 mg/L).
- P and Cu much greater in wastewater and will impose restrictions on wastewater disposal.
- Likely sources of P in wastewater are (1) residues of pesticides containing P on tomatoes and (2) dump tank chloride level.
- Residues of Cu fungicides on tomatoes may be the likely source of Cu in wastewater.

TAKE HOME MESSAGE

- **Wastewater needs to be treated to remove P and Cu before discharging to surface waters/ municipal systems.**
- **Potential treatment options to remove P and Cu may include use of chemical amendments such as alum (aluminum sulfate), ferrous chloride.**
- **Future research should:**
  - **Identify sources of P and Cu in wastewater and ways to decrease there levels (Field BMPs?).**
  - **Evaluate ways to decrease chlorine use (automation?)**
  - **Develop/test a cost-effective small scale pilot treatment system using Fe and Al amendments to remove metals from wastewater.**

ACKNOWLEDGEMENTS

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