Mechanistic investigation into the uptake and translocation of weathered persistent organic pollutants from soil by *Cucurbita* species

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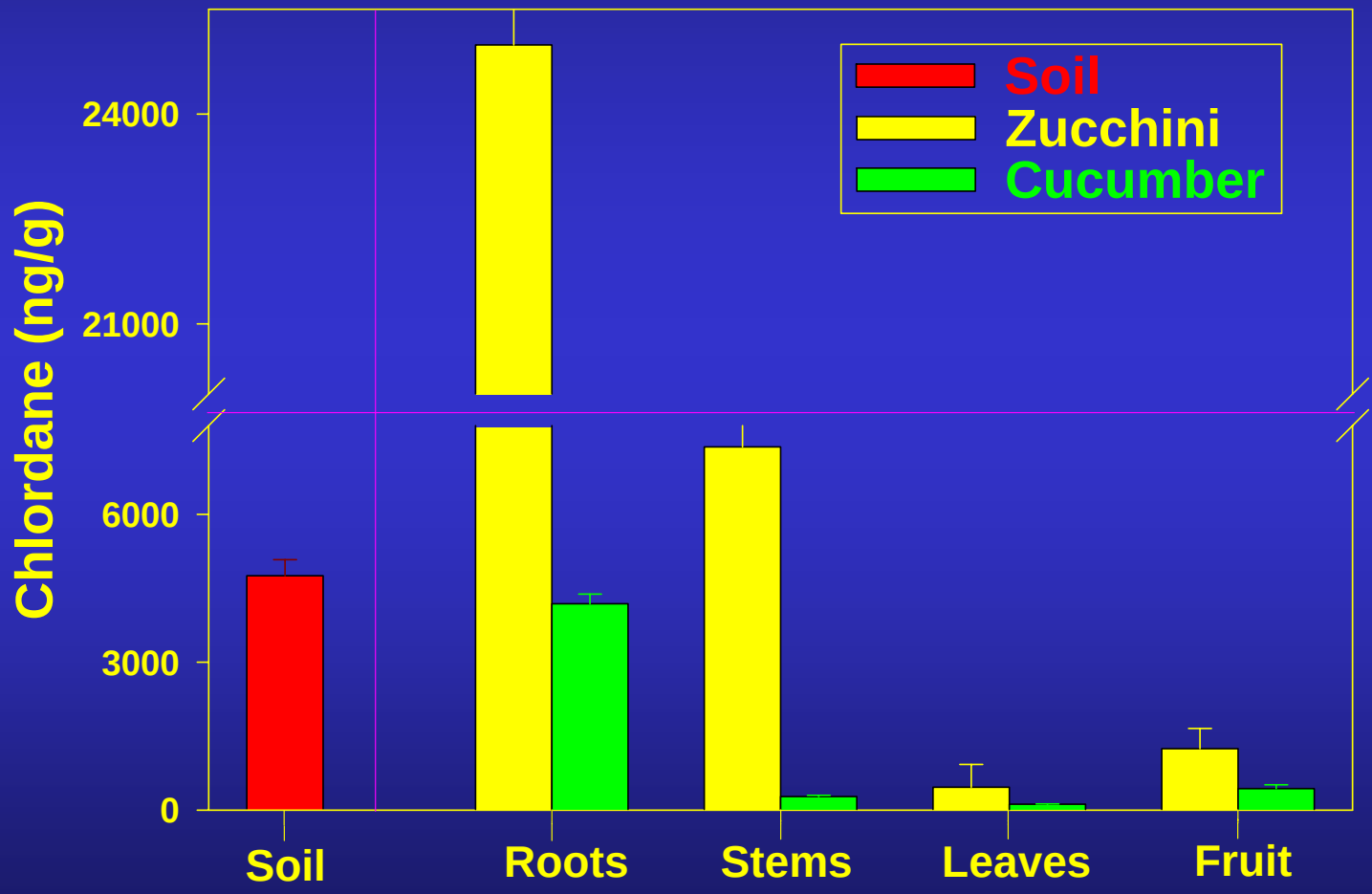
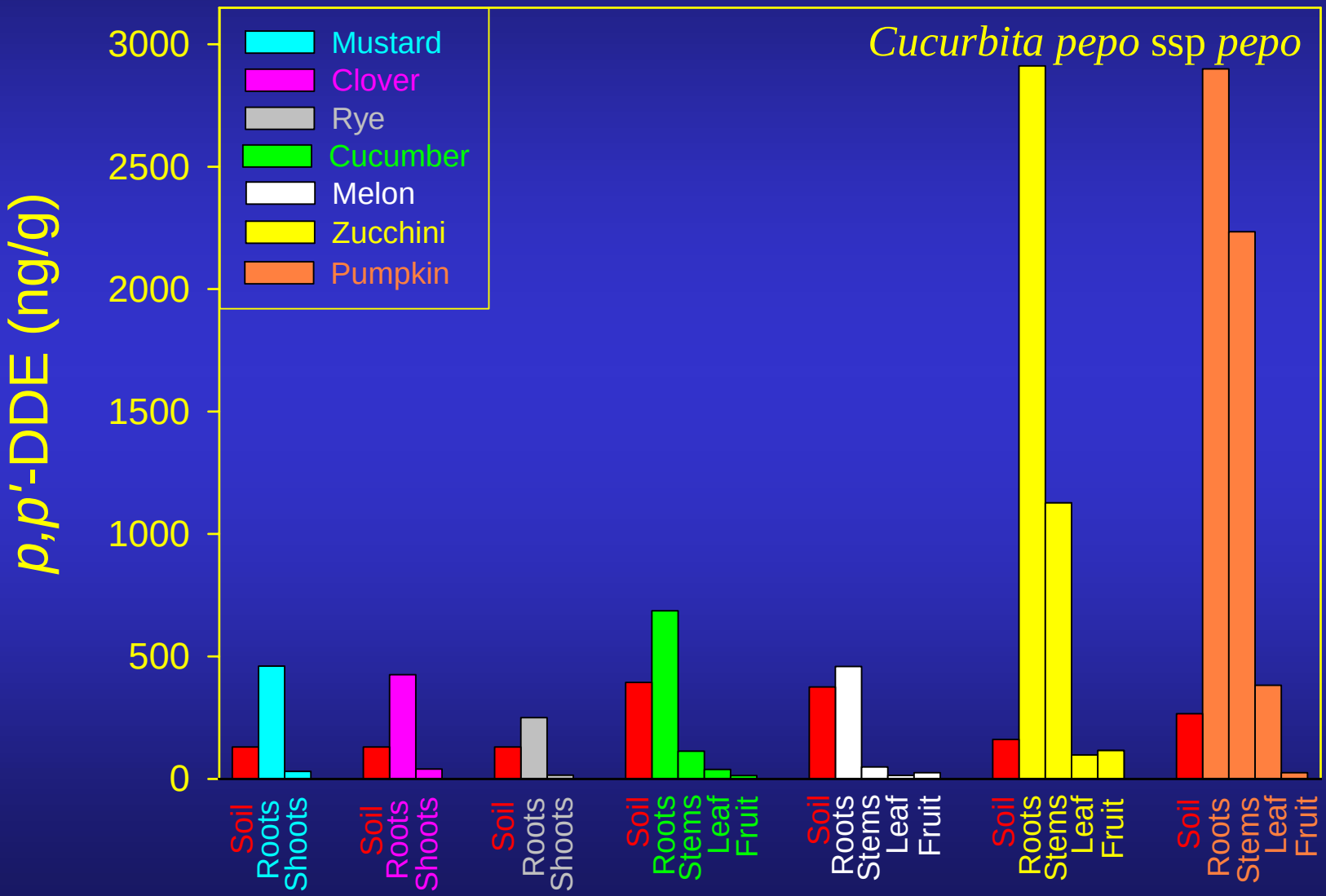
Why look at Persistent Organic Pollutants?

- They persist for decades
- Likely mutagenic, estrogenic, carcinogenic effects
- Bioaccumulation, biomagnification
- Other remediation strategies are ineffective due to high degree of sequestration; plants should not accumulate them

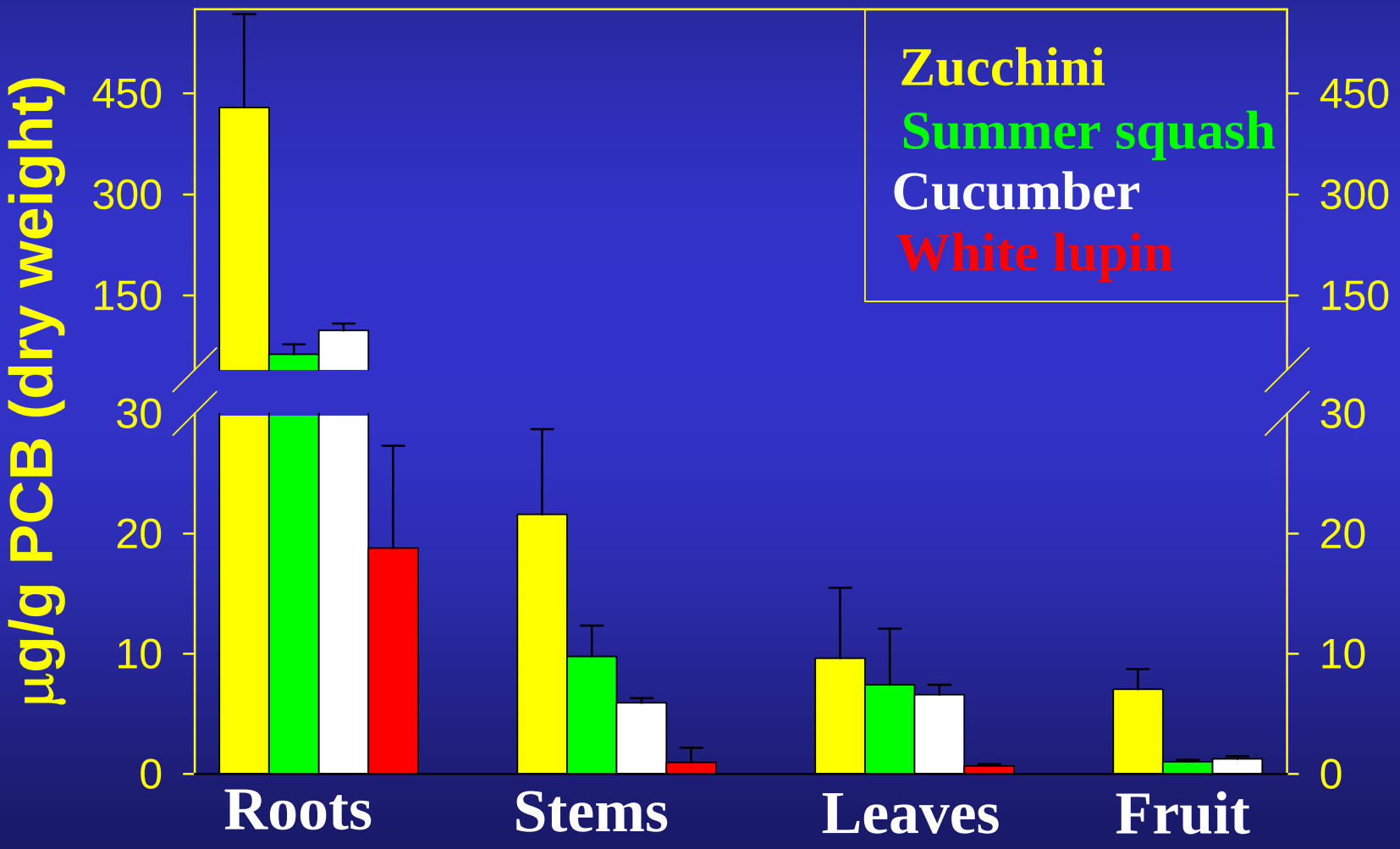
Uptake and translocation of chlordane from soil by zucchini and cucumber



Uptake and translocation of weathered *p,p'*-DDE by selected plant species



Uptake and translocation of weathered PCBs from soil (105 μg/g) by 4 plant species



Average PAH content (ng/g) in roots and stems of 3 cucurbits grown in an MGP soil (37 μg/g)

Tissue	Species	3 Ring	4 Ring	5 Ring	6 Ring
Roots	**Zucchini**	**1800 A**	**5200 A**	**3000 A**	**4100 A**
	Cucumber	350 B	970 B	540 B	640 B
	S. Squash	230 AB	520 B	51 C	0.00 B
Stems	**Zucchini**	560 A	1000 A	59 A	34 A
	Cucumber	18 A	18 A	0.00 A	0.00 A
	S. Squash	230 A	140 A	0.00 A	0.00 A

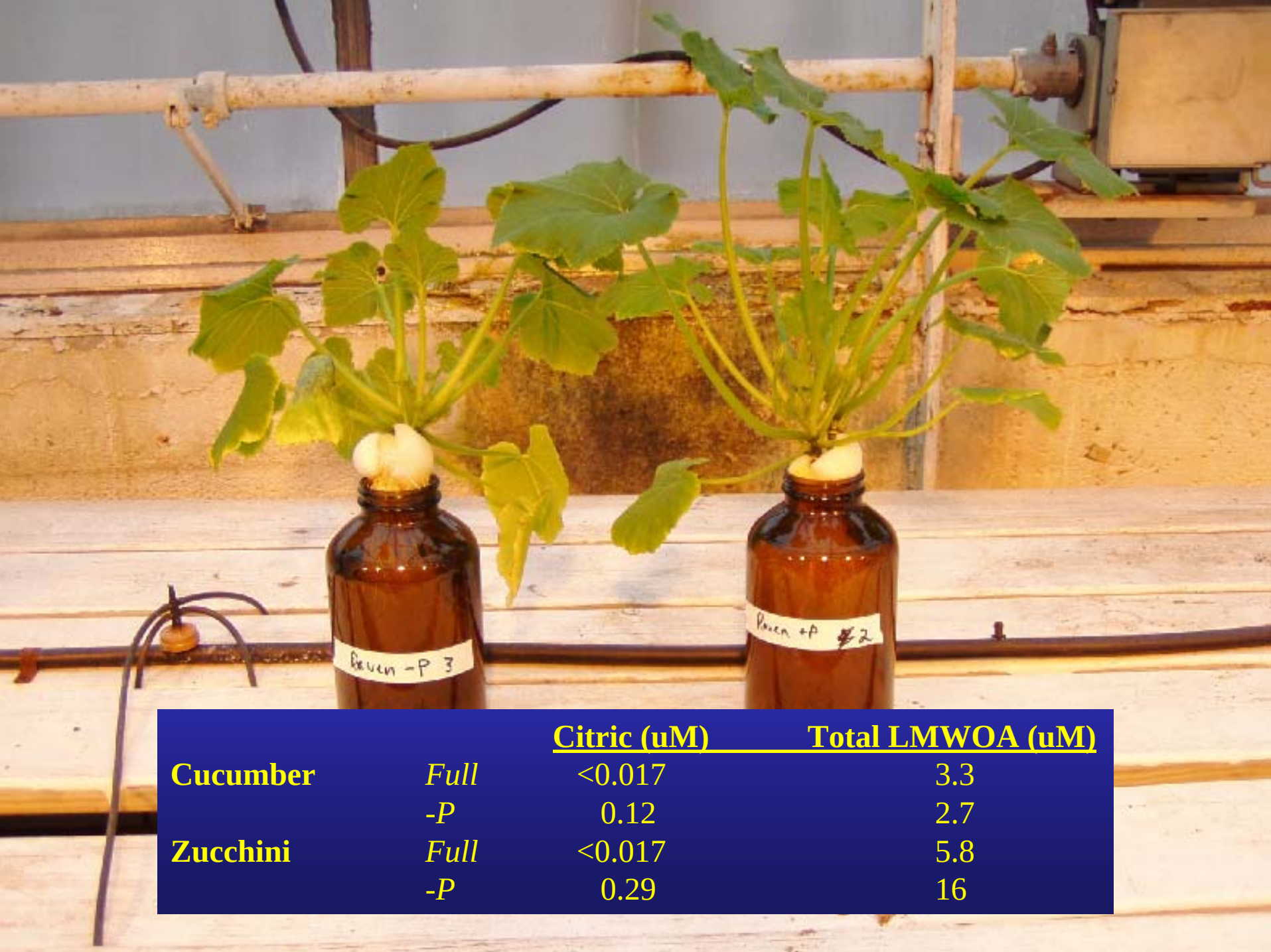
The *C. pepo* ssp *pepo* system

- *C. pepo* ssp *pepo* is unique in 2 areas-

  1. *Ex planta*- Release and uptake of a highly sequestered residue from soil to roots

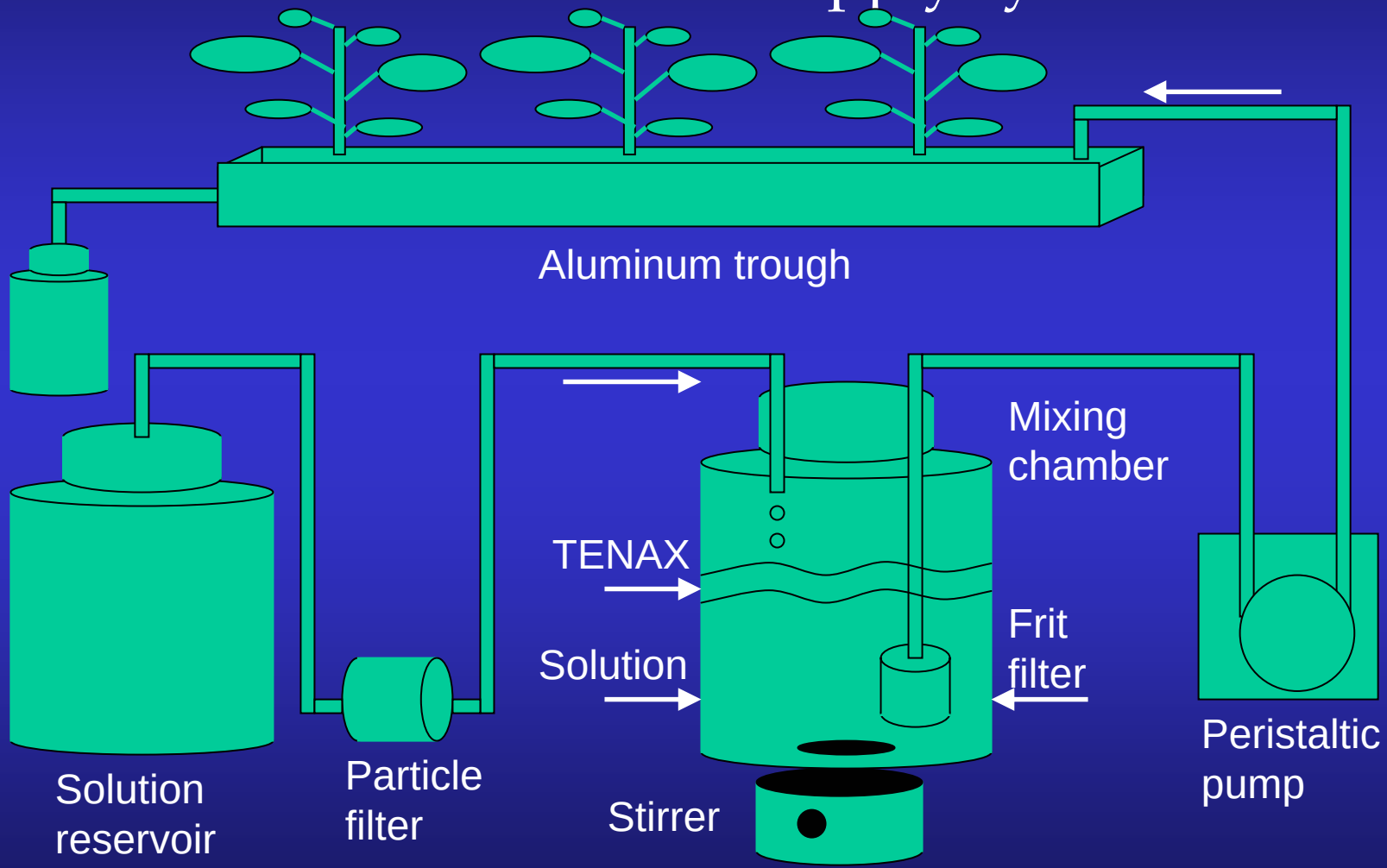
  2. *In planta*- Translocation of a hydrophobic residue from roots to shoots

- For 1., root exudate-mediated soil matrix deconstruction
- Low molecular weight organic acids that scavenge nutrients inadvertently increase the bioavailability of weathered POPs
- For 2., ????



		Citric (uM)	Total LMWOA (uM)
Cucumber	*Full*	<0.017	3.3
	-P	0.12	2.7
Zucchini	*Full*	<0.017	5.8
	-P	0.29	16

Schematic of DDE supply system



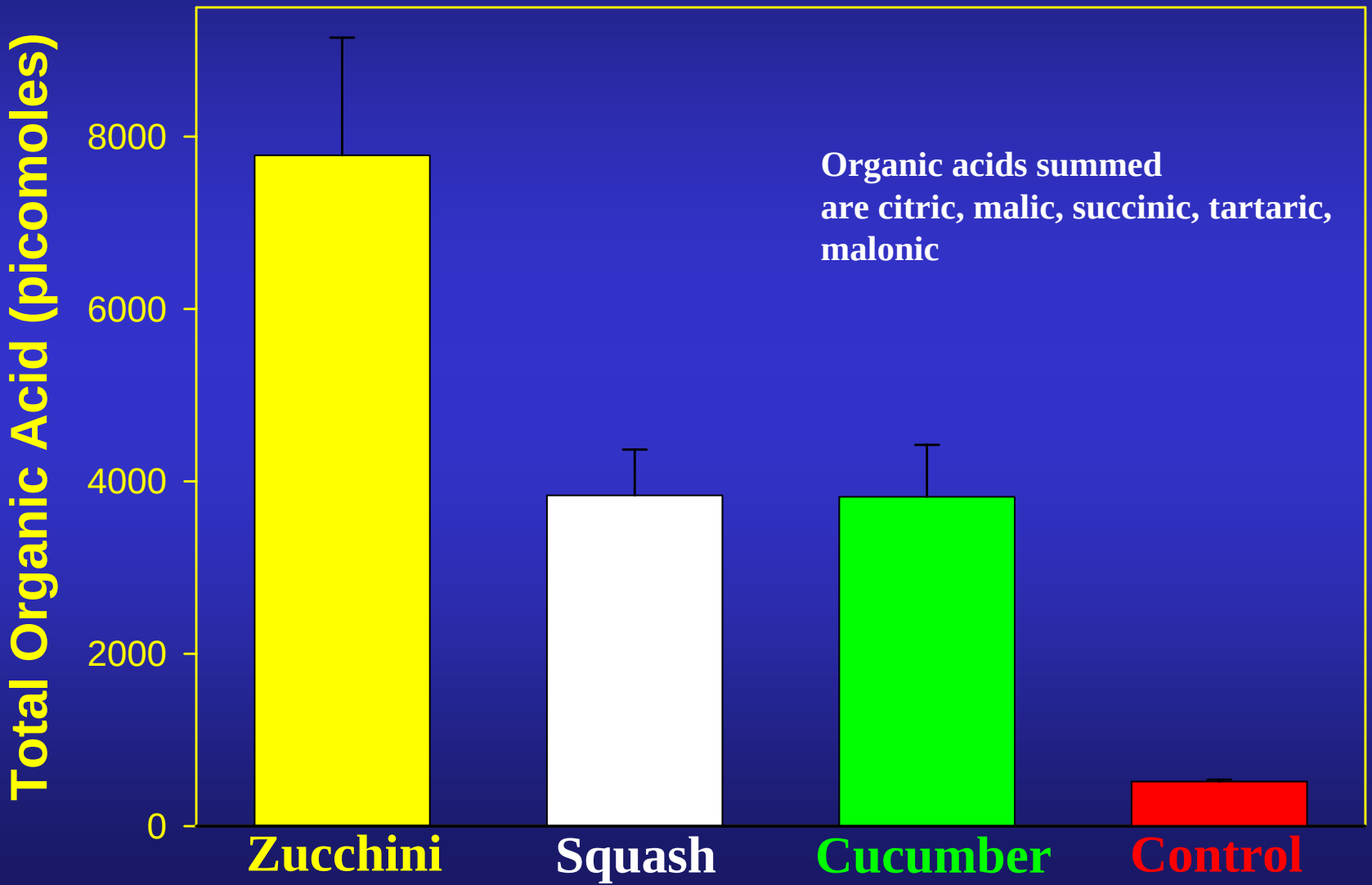
DDE accumulation in cucurbits under hydroponic conditions. Plants were supplied DDE at 2ng/ml at a rate of 2.6 ml/min

Species	Days of exposure	Root (ng/g)	Stem (ng/g)	Petiole (ng/g)	Leaf (ng/g)
Cucumber	8	39,800	100	ND	200
	14	72,400	200	ND	200
Zucchini	8	23,900	1,000	500	800
	14	30,900	2,000	1,000	400

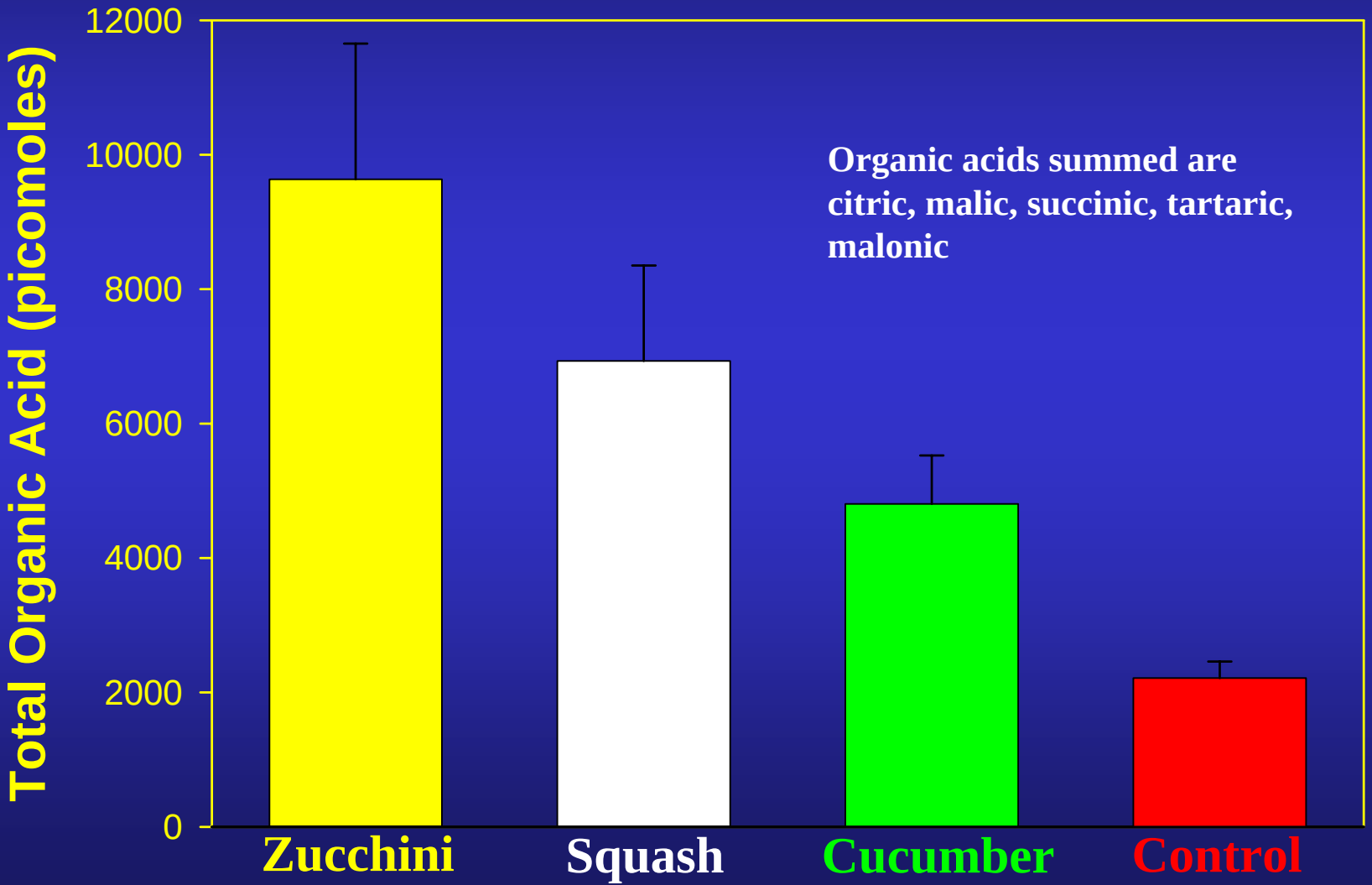
Rhizotron studies: *in situ* analysis of root exudates and rhizosphere pore water

We can collect root exudates directly from the root or from the rhizosphere

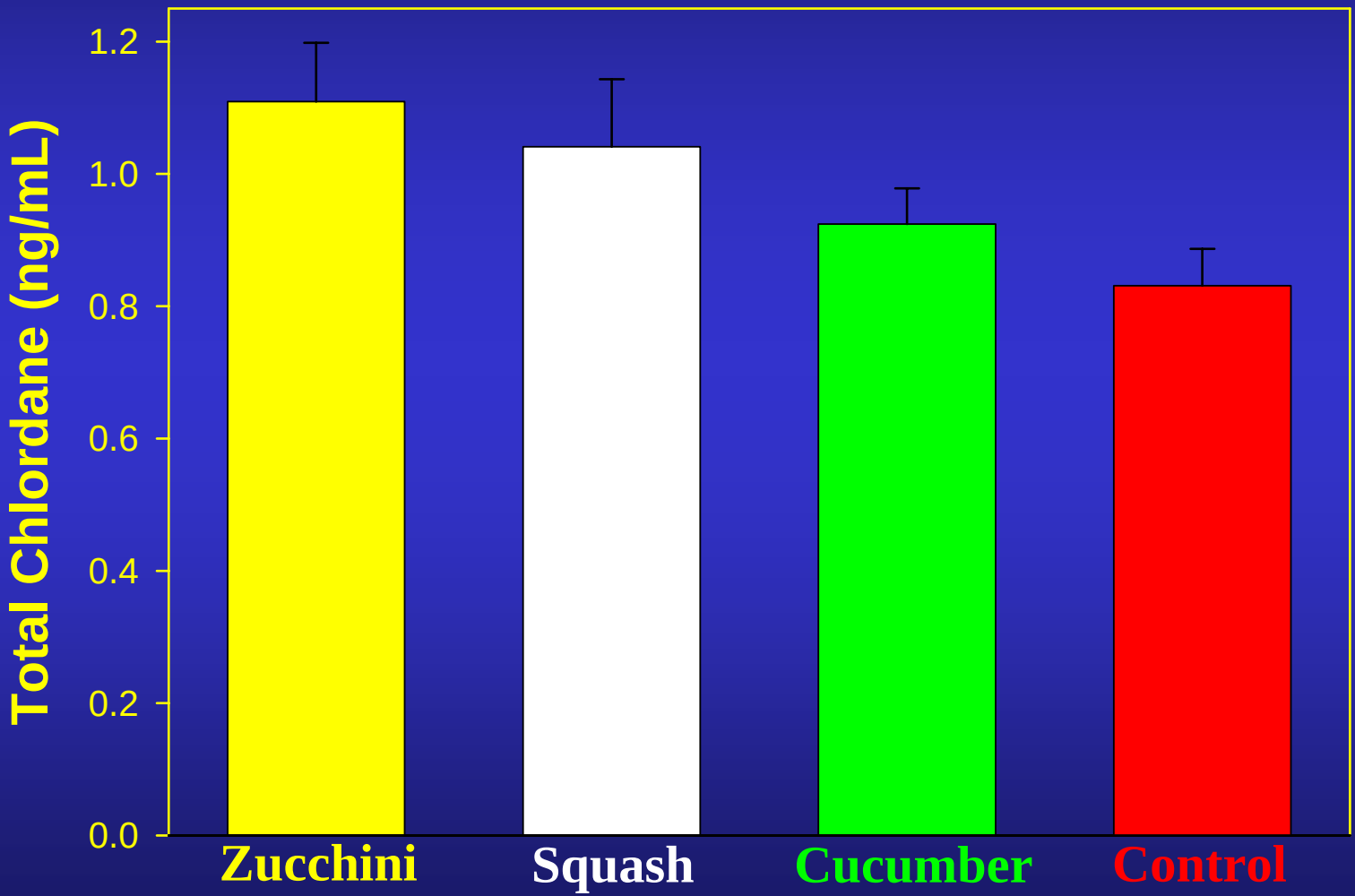
Organic acids on quartz fiber filters in contact with the roots of 3 cucurbits and in non-vegetated soil



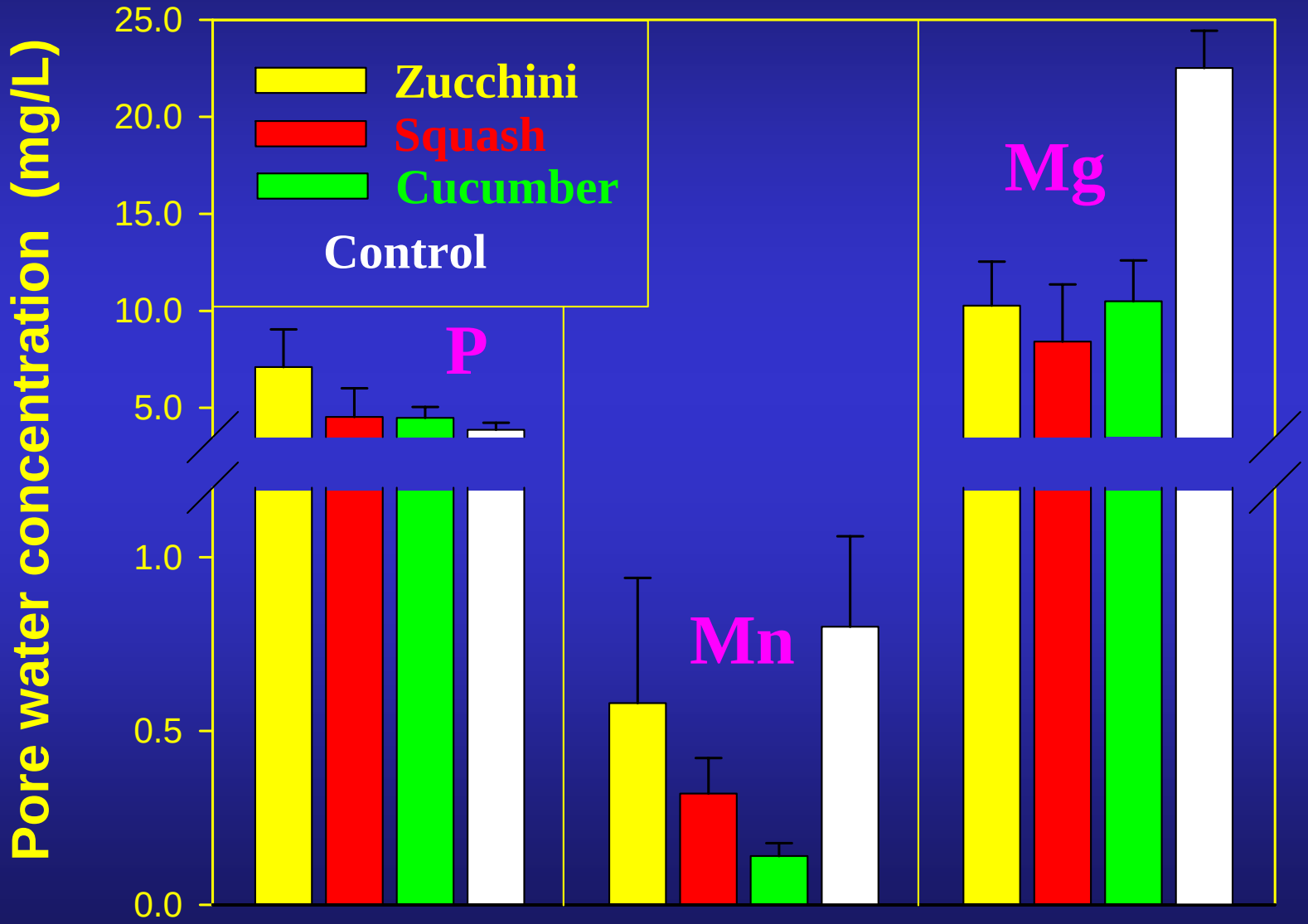
Organic acids in rhizosphere pore water of 3 cucurbits and in non-vegetated soil



Amount of chlordane in the rhizosphere pore water of 3 cucurbits and in non-vegetated soil



Concentration of select elements in the pore water of 3 cucurbits and of non-vegetated controls



Collection of Xylem Sap

-- Sever plant stem > 1 cm above soil surface

-- Allow sap to bleed for 1-2 minutes, wipe cut surface

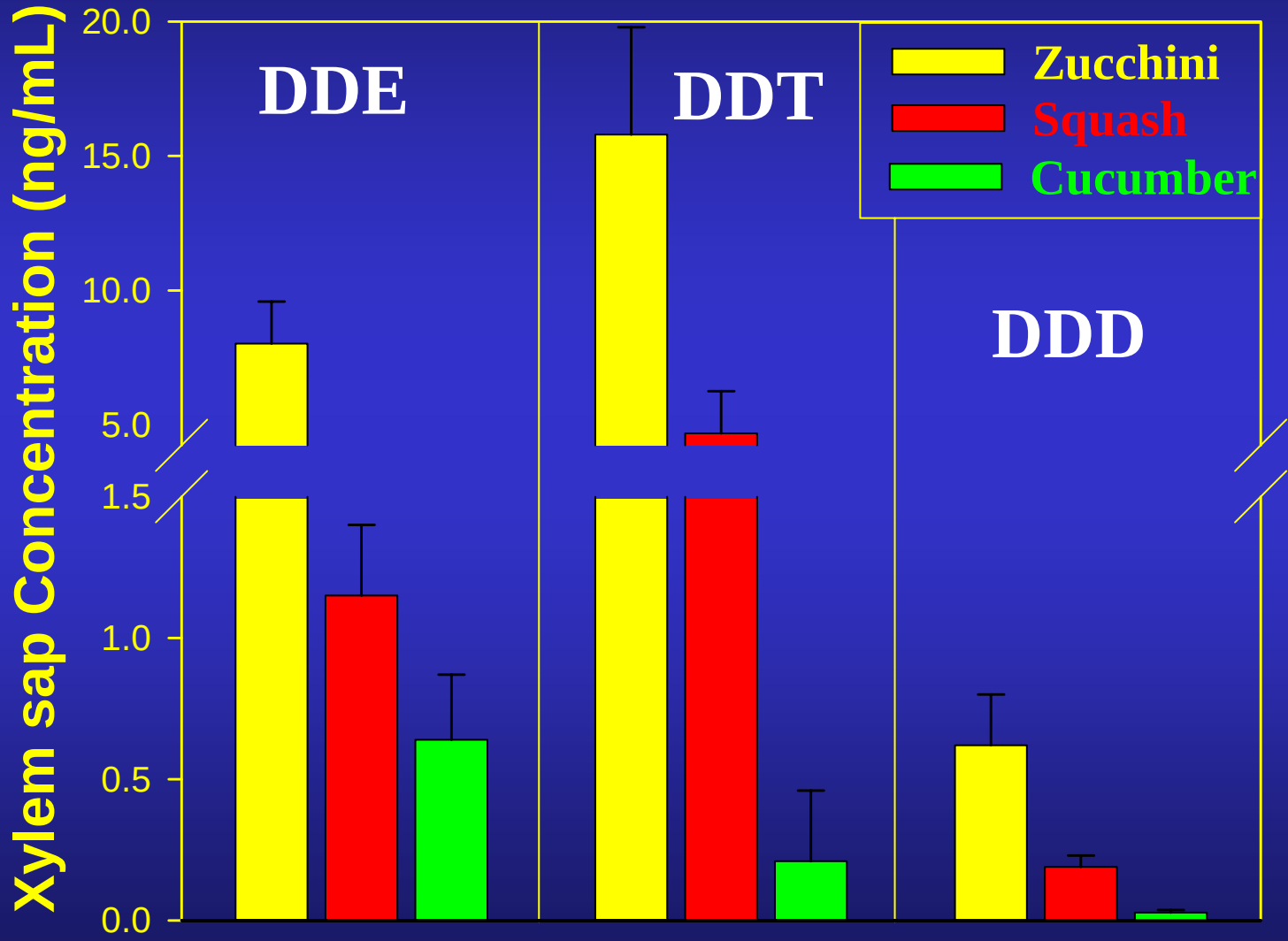
-- Collect sap via capillary action

-- Keep sap cooled throughout timed collection

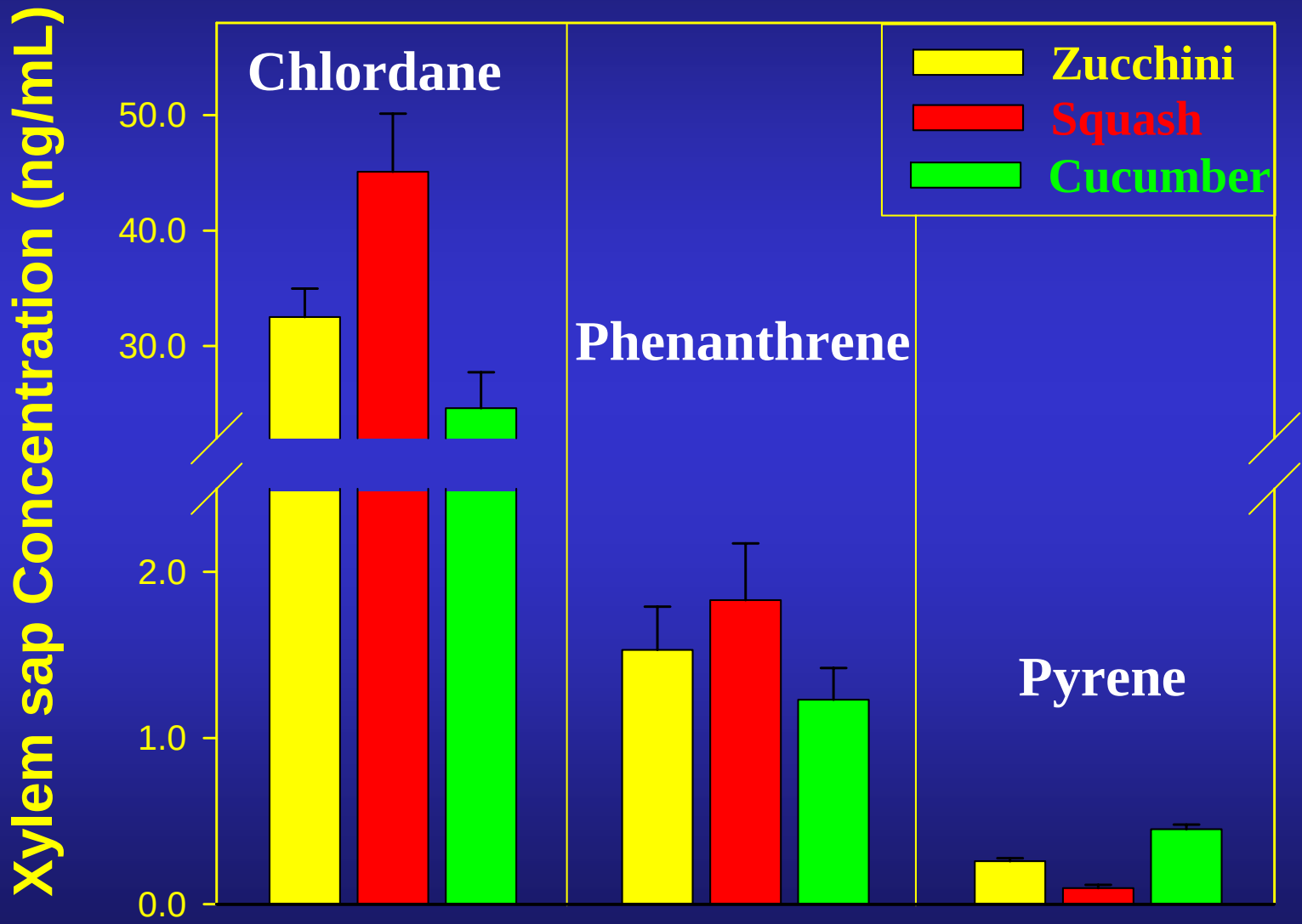
-- Extract POPs from aqueous sap via SPME

-- Desorb SPME onto chiral GC column interfaced to ITD

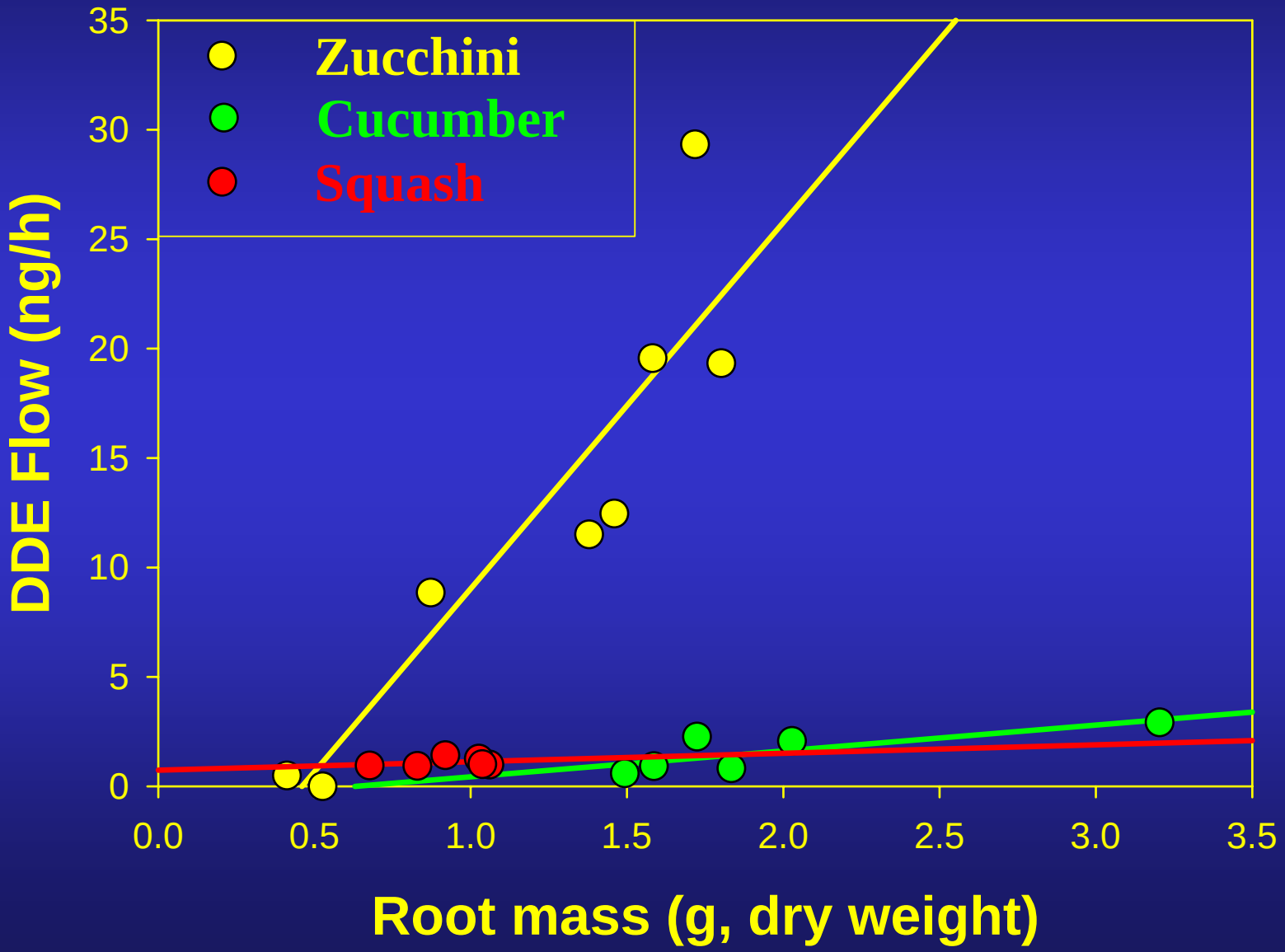
Concentration in of DDT and metabolites in the xylem sap of 3 cucurbits



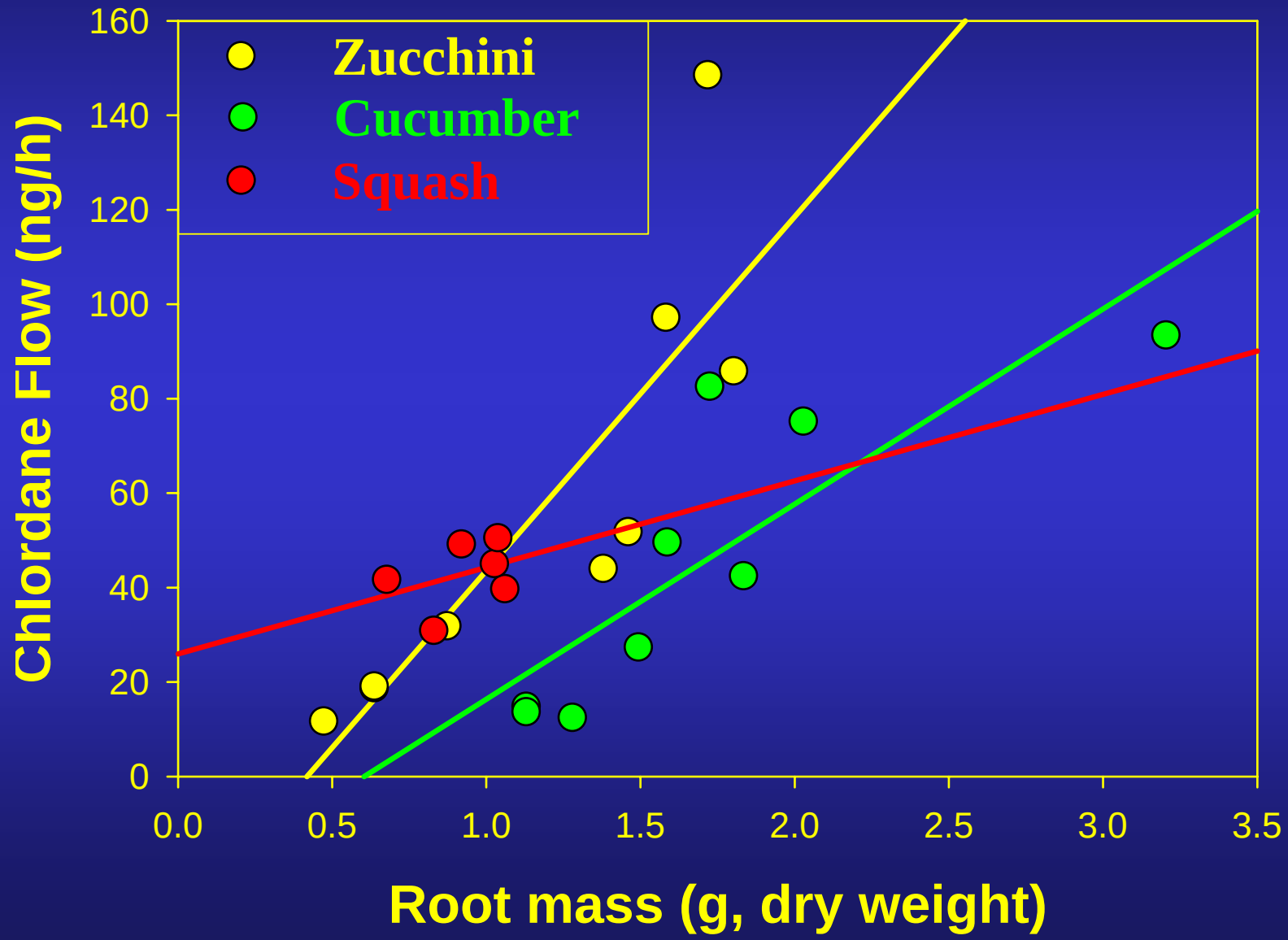
Concentration of other POPs in the xylem sap of 3 cucurbits



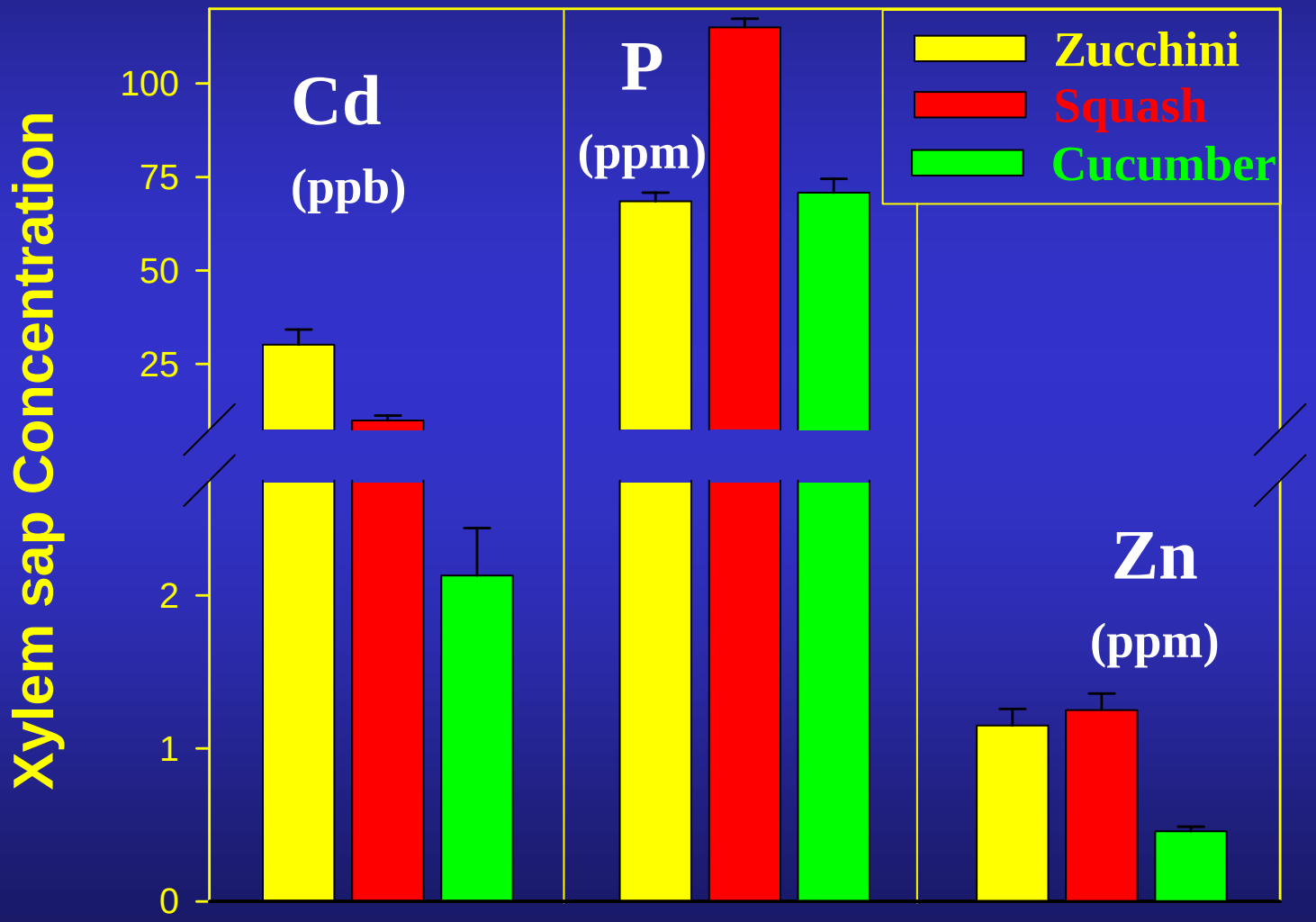
Rate of DDE Flow in the Xylem Sap of 3 Cucurbits



Rate of Chlordane Flow in the Xylem Sap of 3 Cucurbits



Concentration of elements in xylem sap of 3 cucurbits



Conclusions

- *C. pepo* ssp *pepo* uniquely phytoextracts significant quantities of weathered POPs
- The mechanisms are somewhat non-specific, as widely different contaminants are accumulated to varying extents, including DDE, chlordane, PAHs, PCBs, and dioxins
- This is not a specifically evolved ability; POPs are entering on pre-existing physiological systems, unique patterns of nutrient acquisition via LMWOA exudation being one likely candidate
- The mechanism of intra-plant translocation of hydrophobic organic compounds is under investigation
- Elucidating these mechanisms is of interest on several fronts, including development of a novel phytoremediation system

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