Recovery Plan for Zebra Chip of Potato

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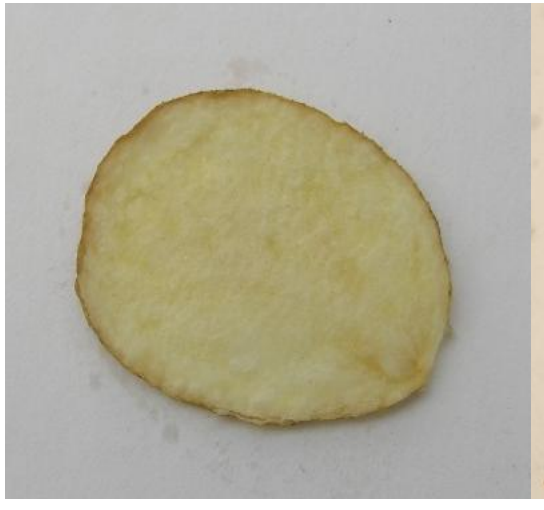
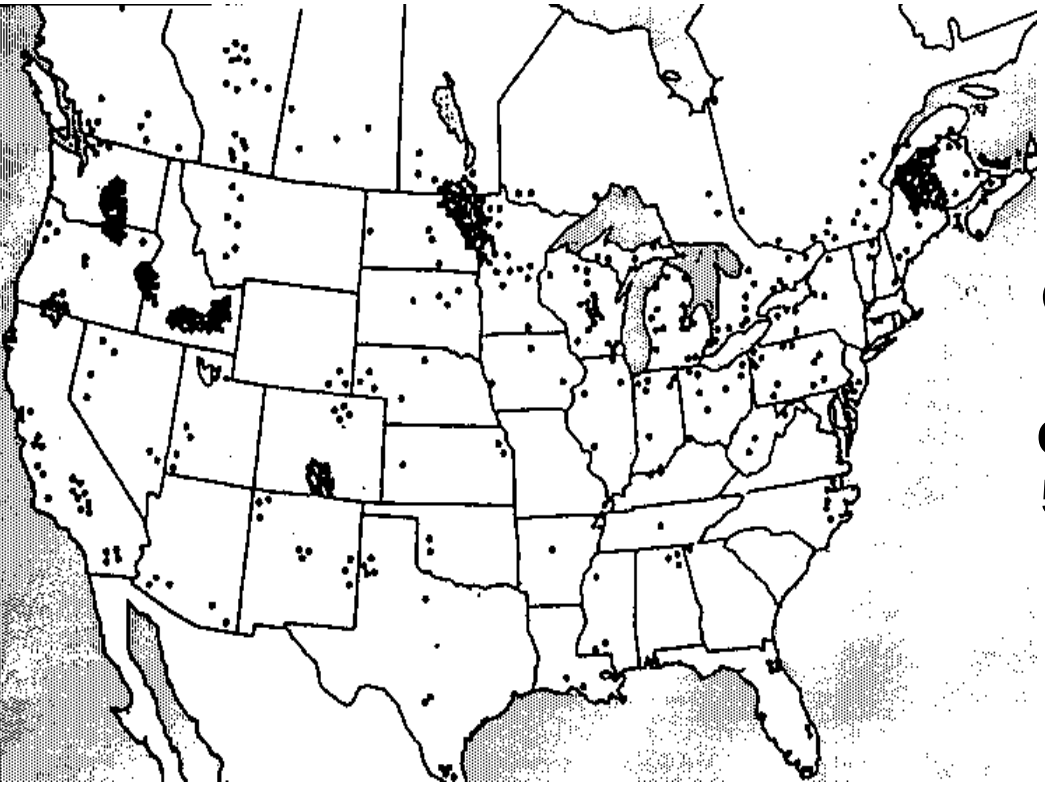
Texas A&M AgriLife Research - Amarillo

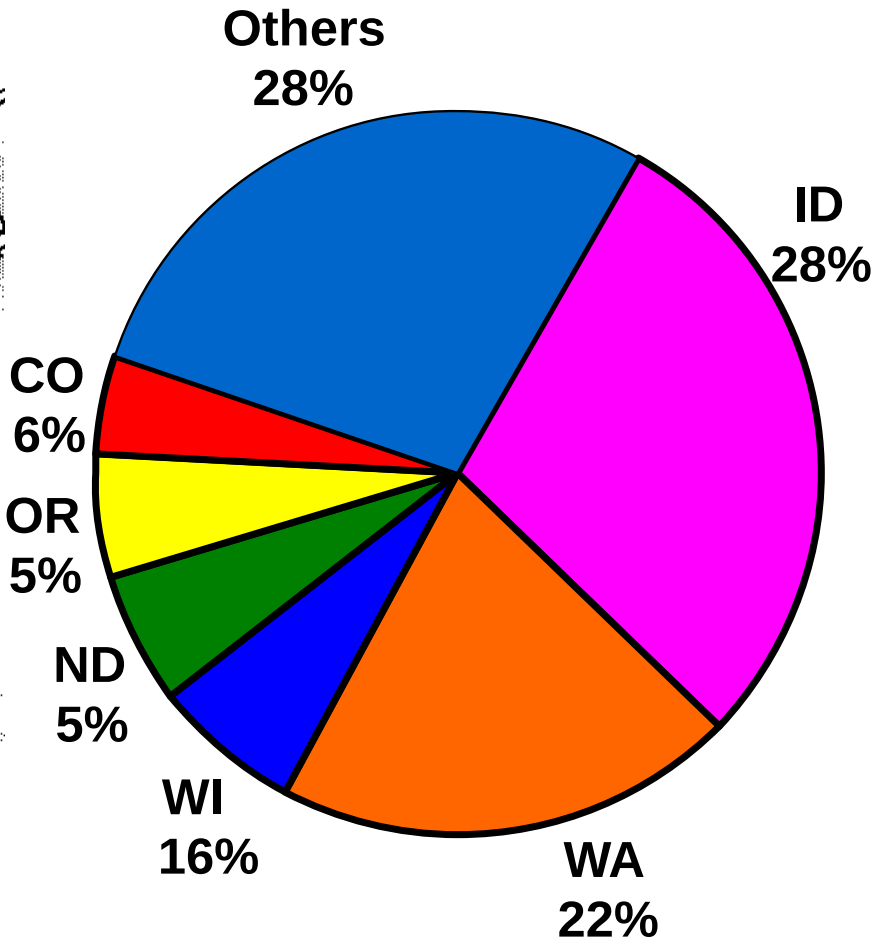
National Plant Disease Recovery System Meeting
American Phytopathological Society
Portland, Oregon
August 10, 2014



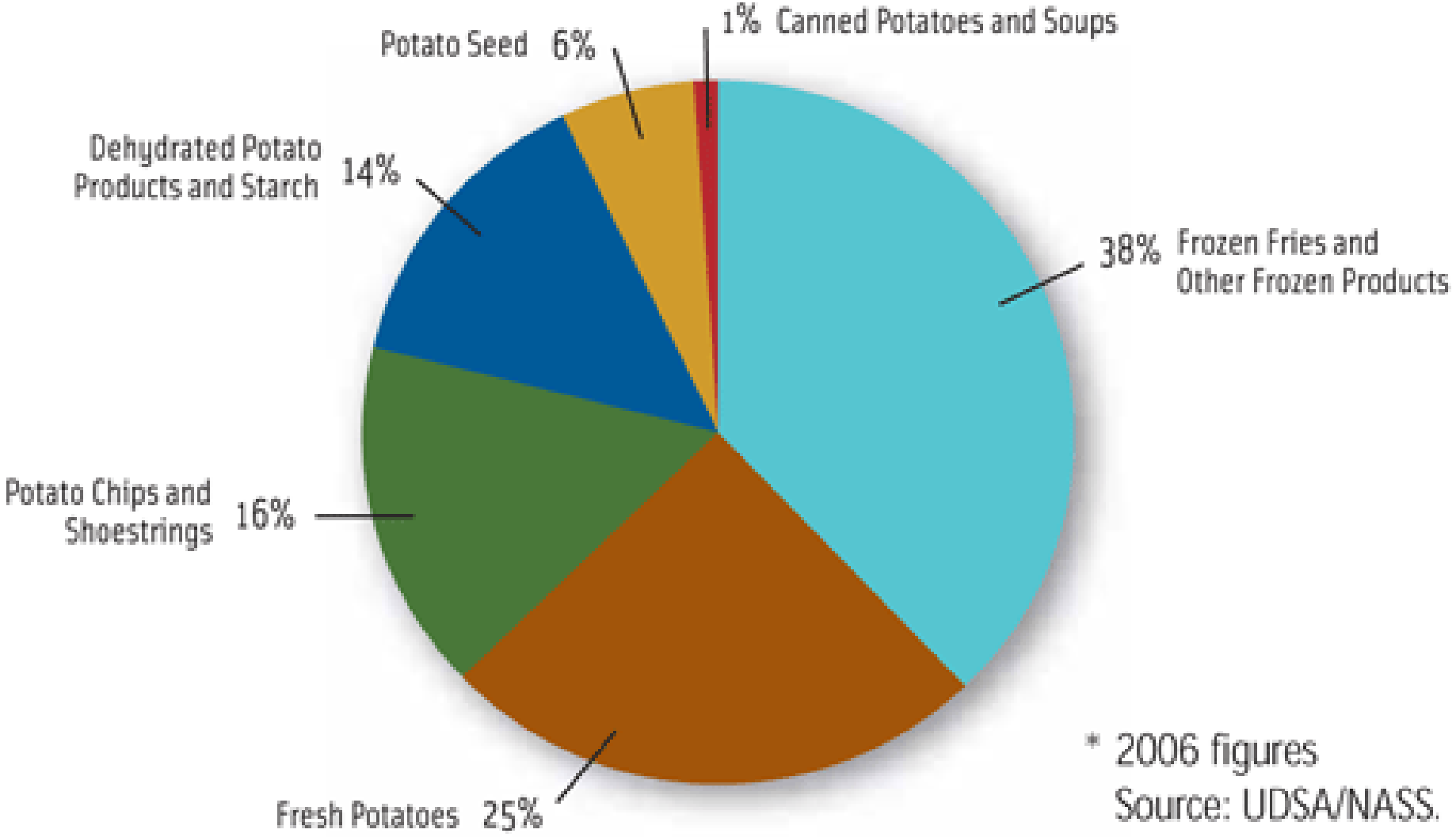
U.S. Potato Production

- **Potatoes are grown commercially in 36 states**





Use of Potatoes in U.S.

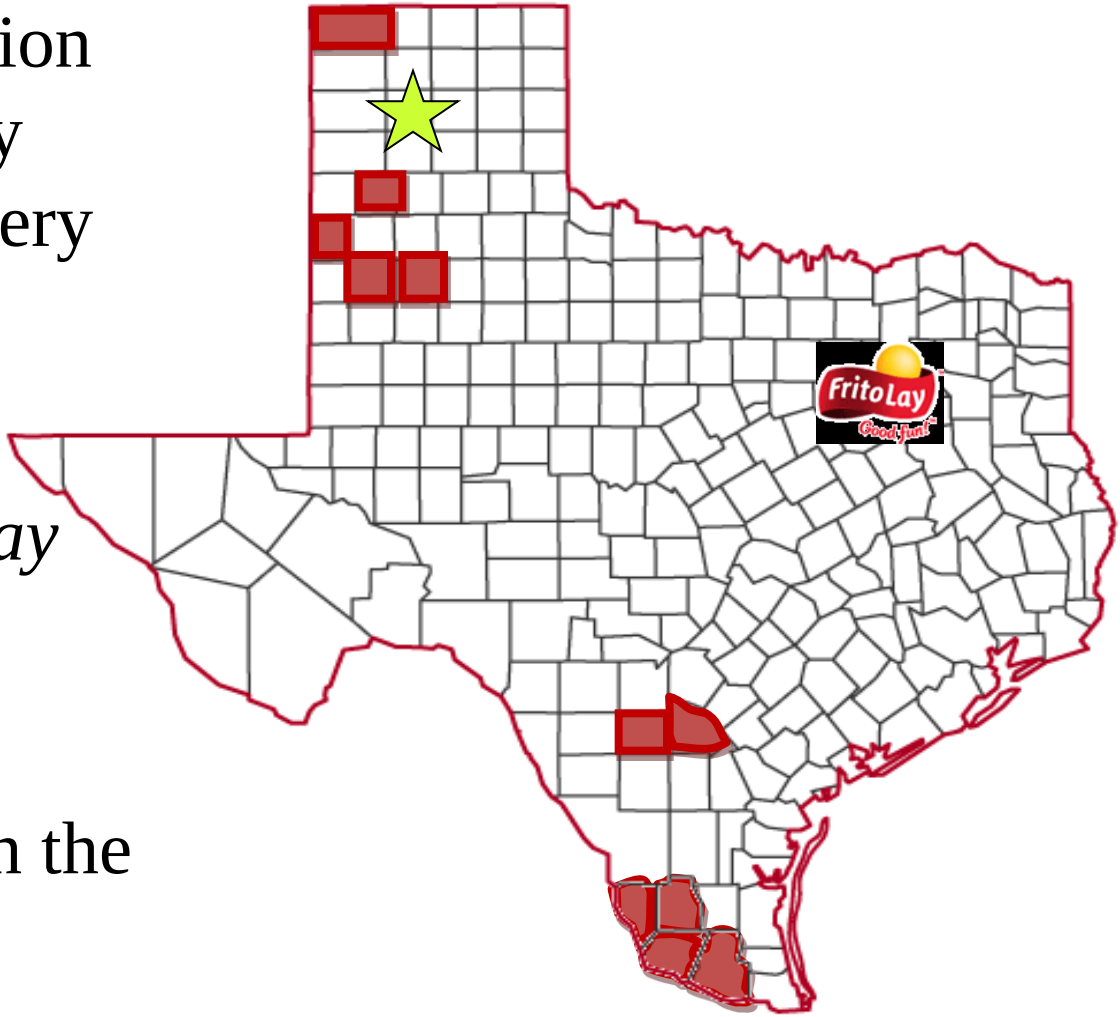


Texas Potato Production

• Texas production -7 million cwt/yr from approximately 20,000 acres – irrigated, very high quality product.

•Seventy percent of Texas production goes to *FritoLay* for potato chips!

•FritoLay is the largest producer of potato chips in the US.



Potato Processing

Fry Test for Quality

Quality Problems in 2000 -"Texas Defect"

- **Initially called "Texas Defect" but soon renamed Zebra Chip (ZC) to describe symptoms in fried chips and eliminate state bias**
- **Unknown etiology**

Zebra Chip of Potato: A New Threat of Unknown Etiology to US Potato Production

When ZC was first identified, the cause of the disease was unknown, making identification, management and all investigative research extremely difficult

- **Foliar symptoms are variable and unreliable for diagnostics**
- **Tuber symptoms distinctive**









Complete Loss on 500 Acre Center Pivot

Summary of Events

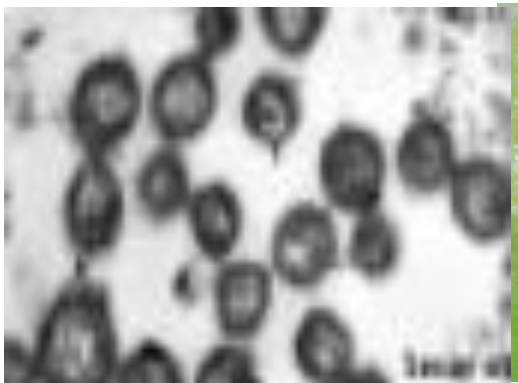
- **2000 – Zebra Chip first identified in USA from South Texas**

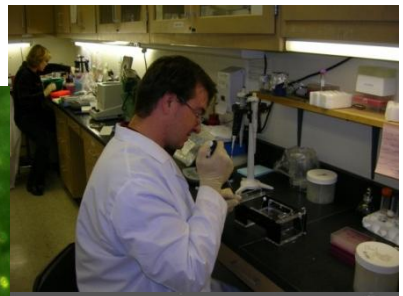
- **2001 -2006 – ZC spread throughout Texas and northward to Colorado, Kansas, Nebraska and Wyoming (identified in some seed production areas)**

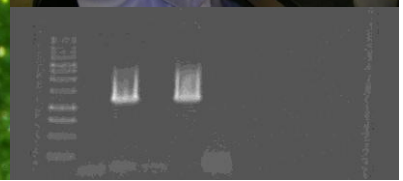
- **2008 - Two seminal discoveries: Fastidious, phloem-limited bacterium *Candidatus* Liberibacter solanacearum was reported as the putative pathogen causing ZC and the Potato Psyllid was reported as vector – accurate diagnostic techniques were rapidly developed**

- **2009 - A five year Federal SCRI grant ($6.9M) was awarded to a multistate, multidisciplinary team to study all aspects of ZC.**

- **2011 – ZC first reported in the Pacific Northwest**

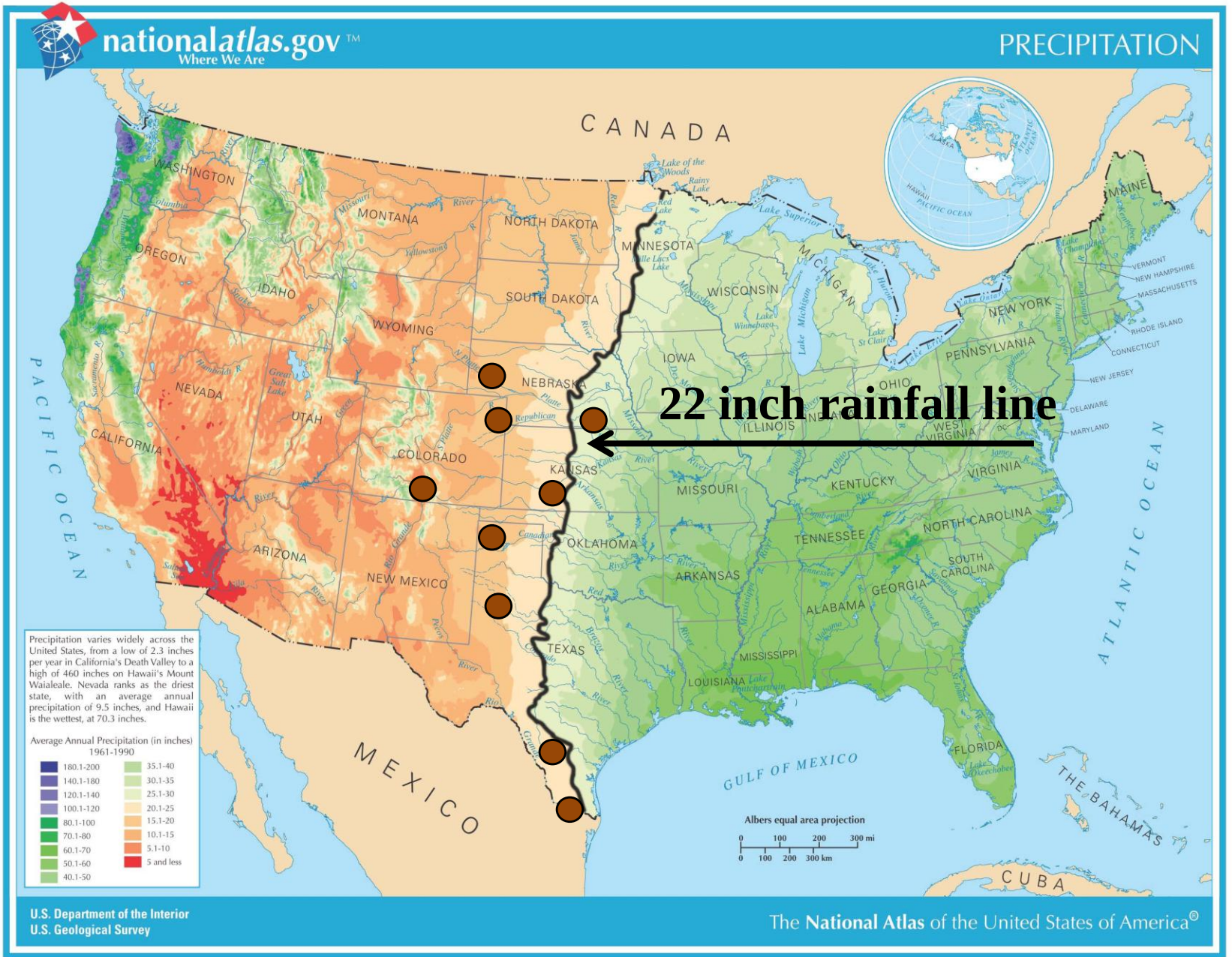






Current Distribution of ZC in US

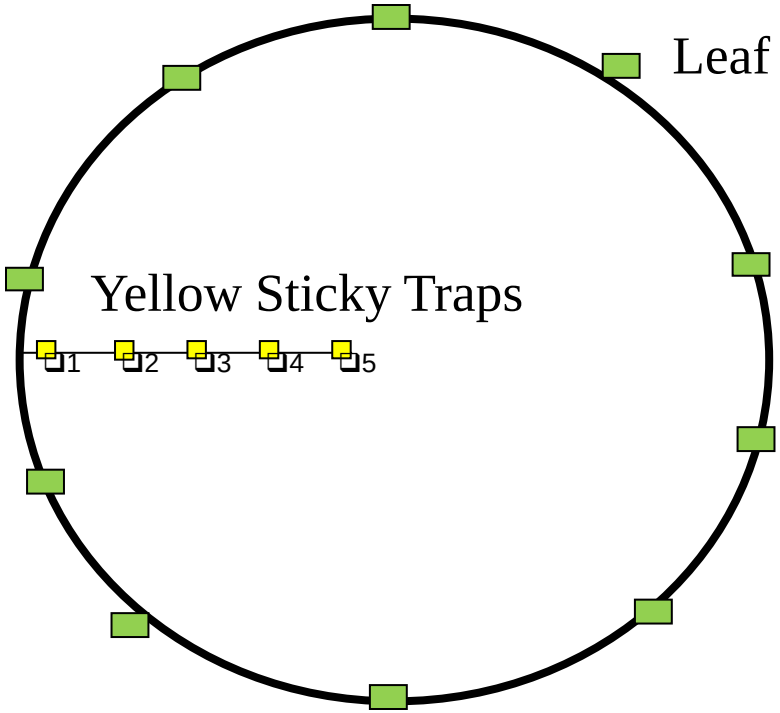
ZC is Most Prevalent in Drier Regions



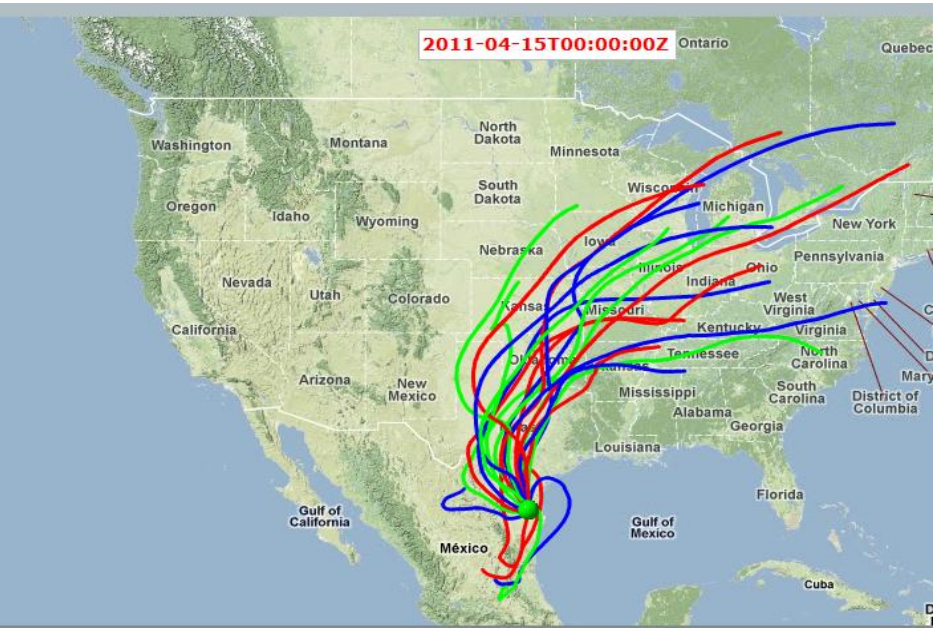
Psyllid Migration and Diversity

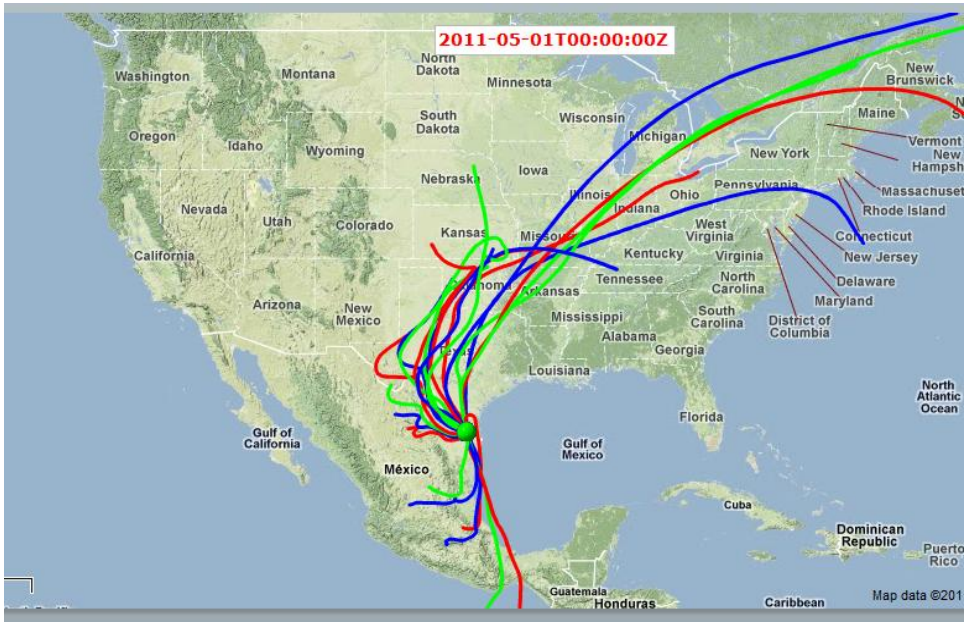
Psyllid Monitoring Program

- Samples from > 20 locations in CO, KS, ND, NE, NM, MN, TX, WI and Manitoba
- Approximately 30,000 psyllids have been tested for Lso since inception of the program in 2009
- Results provided weekly to > 200 growers, scouts and industry personnel



Psyllid Migration - Air Parcel Trajectory





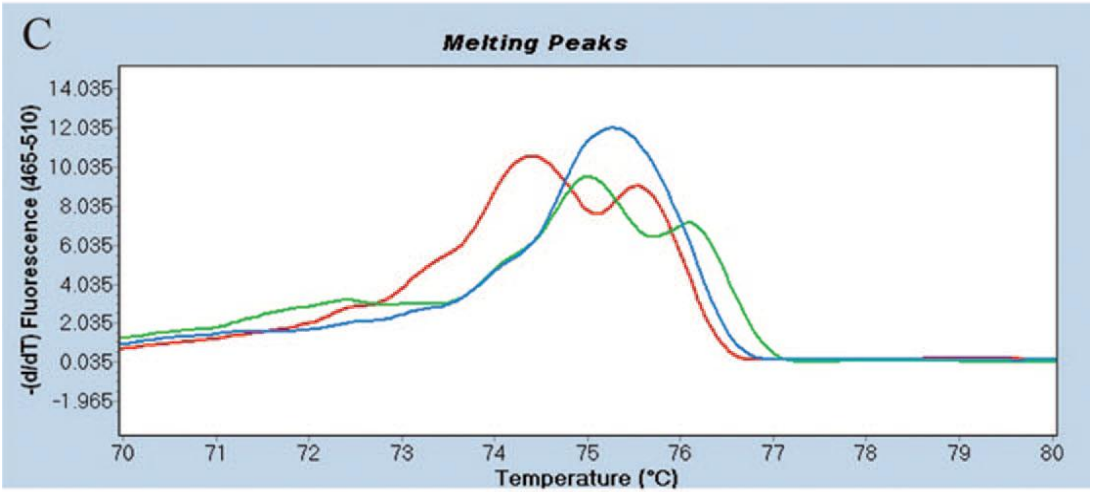
Survival in non-crop areas north of Mexico

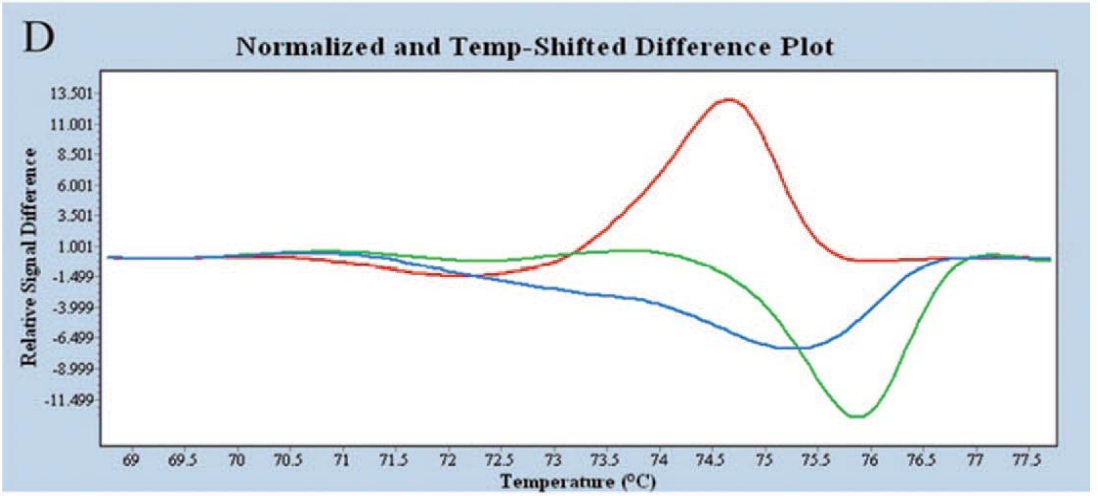
- Psyllids captured year around
- Psyllids captured from Nebraska had greater cold tolerance than psyllids from Texas

Molecular Comparison of Psyllid Populations

*High Resolution Melting Analysis***

- Method to differentiate populations of psyllids
- Used *B. cockerelli* mitochondrial Cytochrome C Oxidase subunit I-like gene
- Over 450 psyllids from Southwest, Central and Northwest USA included in test
- Psyllids from the Pacific Northwest were clearly a different population





California Colony #118
Prosser, Washington #126
Weslaco, Texas #4

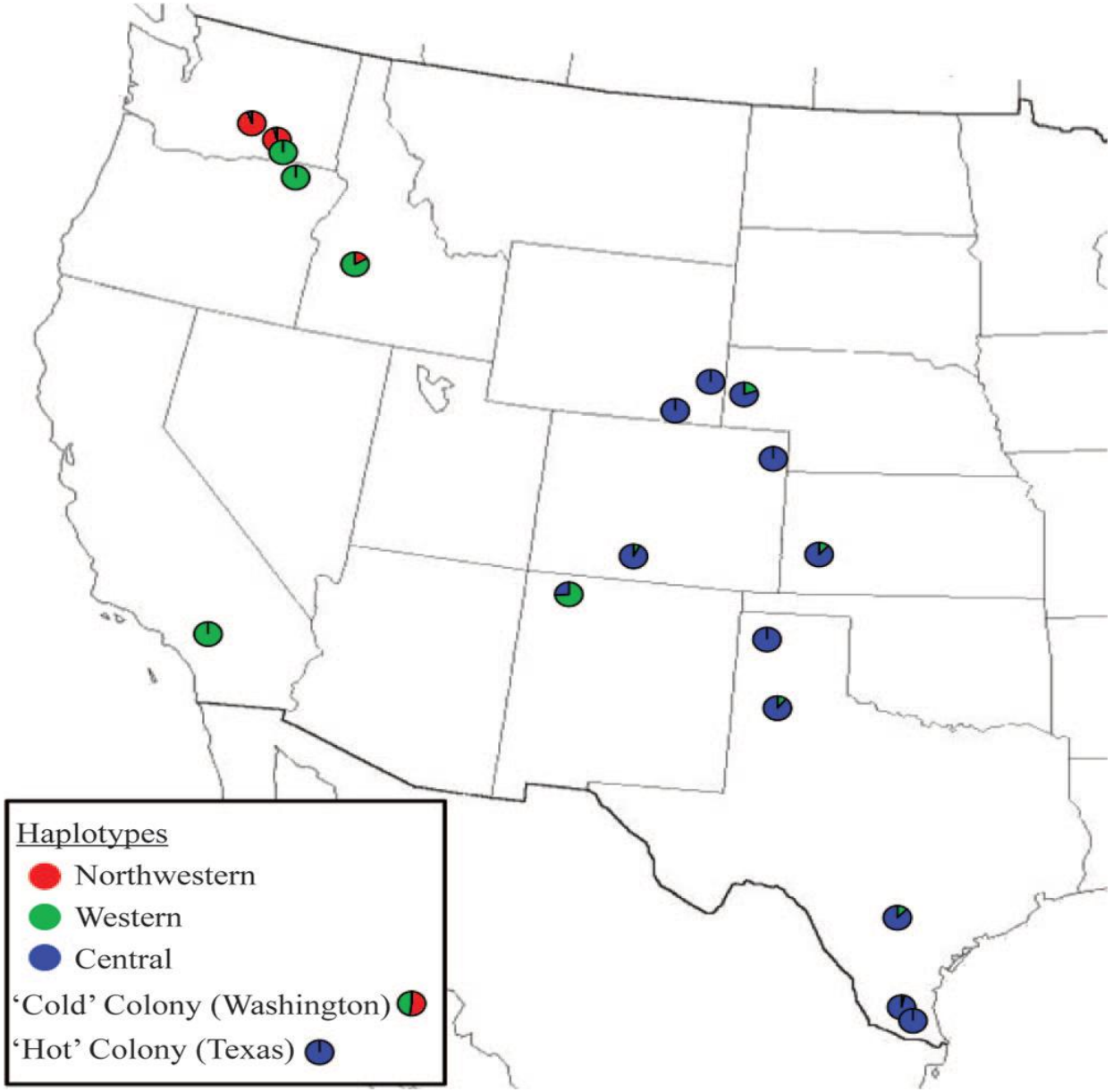
**Kylie Swisher, J. Munyaneza and J. Crosslin. 2012. Environ. Entomol. 41(4): 1019-1028.

*Distribution of Potato Psyllid Haplotypes***

- DNA sequencing of psyllids supported identification of three distinct populations

- Discovery of unique population in the PNW raised questions about migration theory*

**** In 2011, potato psyllid overwintered near Boise, ID on Bittersweet nightshade (*Solanum dulcamara*). Observations confirmed in 2012-2013 in ID and WA.**



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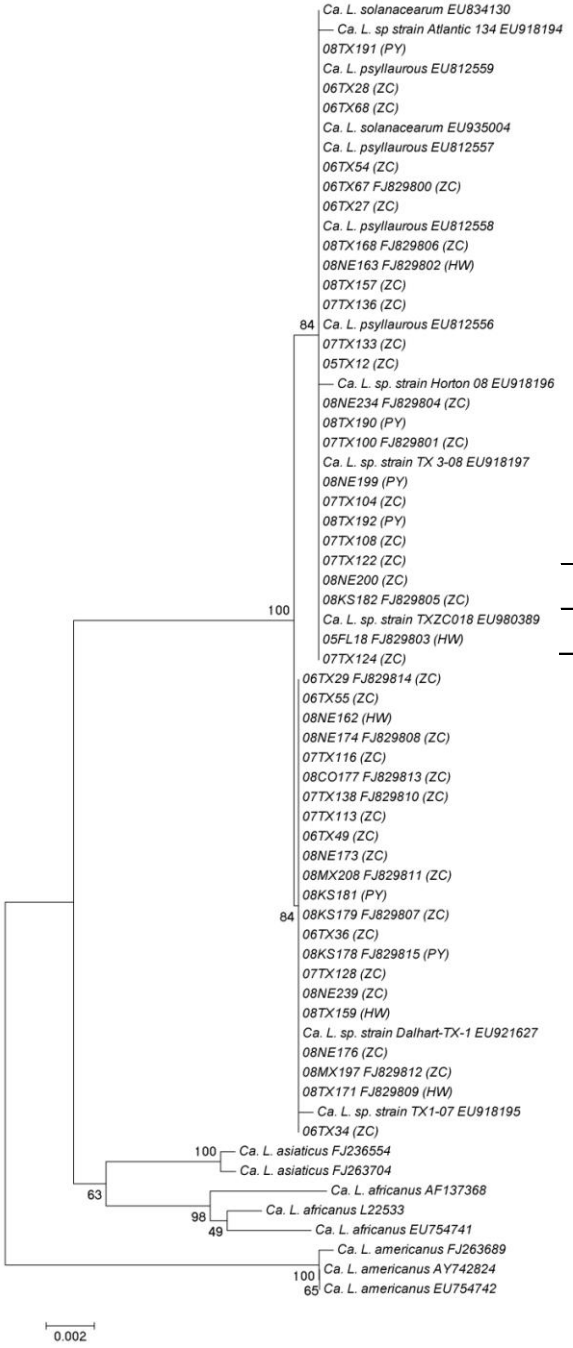
Variation in Lso



Clade 1 (C1)

SNP	1891-1892	1897-1898	1977	2089	2252	2294
C1	-	-	G	C	G	C
C2	G	T	A	T	A	T

Clade 2 (C2)

- Lso separates into two types, designated A&B
- In preliminary studies, B type was more aggressive
- No solid evidence of vector preference for Lso haplotype

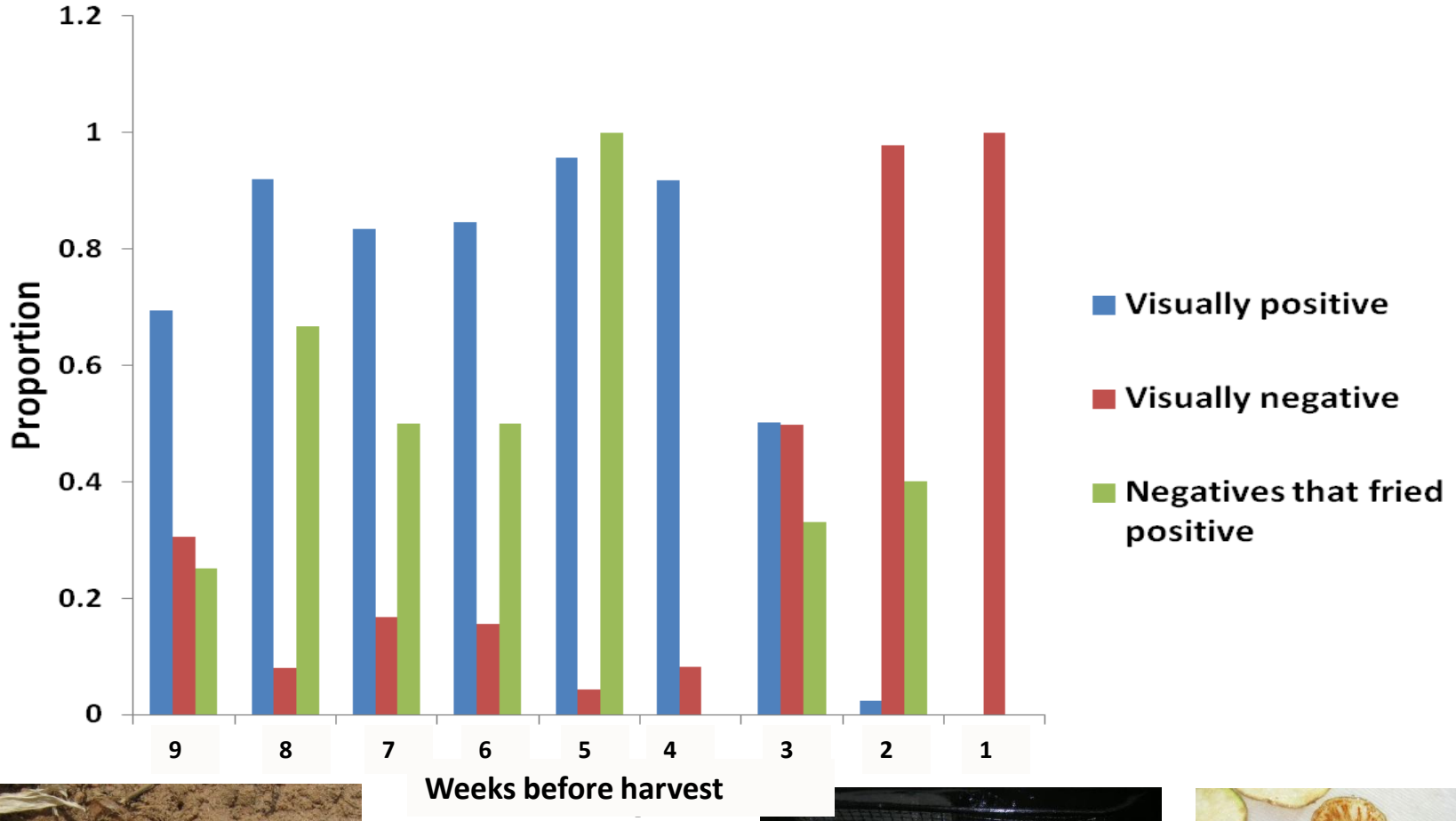
Wen et al, 2009 Plant Dis. 93:1102-1115

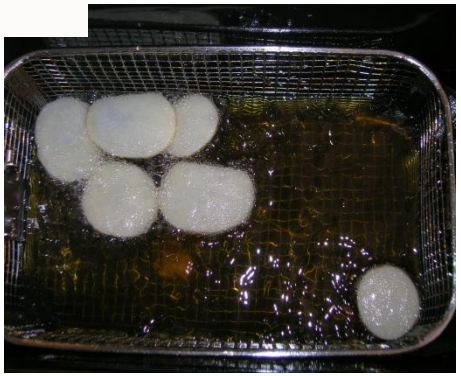
Photo: Courtesy Cecilia Tamborindeguy

Lso in Planta Distribution Determined by cPCR Assays

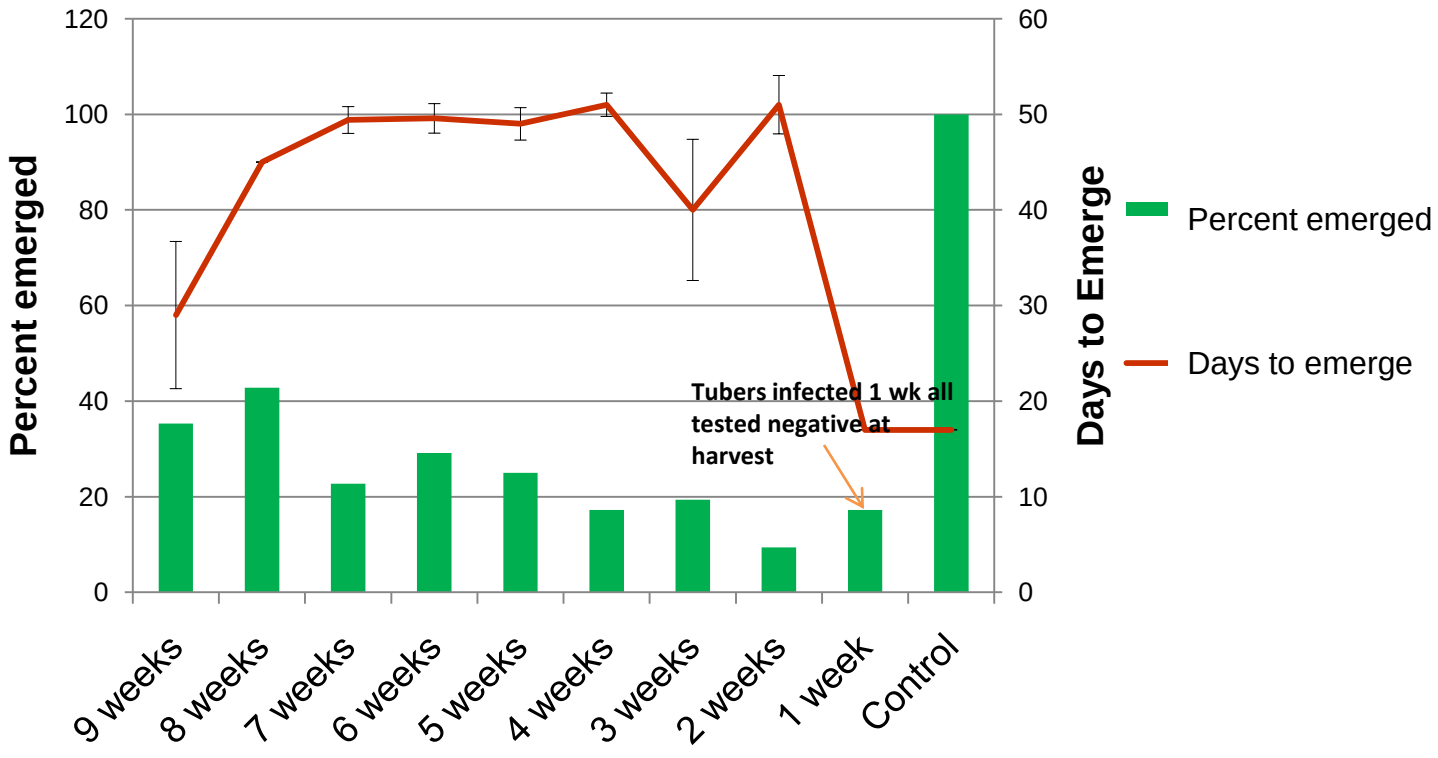
Plant tissue (12 field potato samples)	cPCR assay (Lso positive%)			Real-time PCR	Mean
	Wen et al, 2009	Liefting et al, 2009	Hansen et al, 2008	ZCf/HLBr/ HLBp	
leaf	0.0	0.0	16.7	8.3	6.3 c
midvein	0.0	8.3	33.3	16.7	14.6 c
petiole	16.7	33.3	50.0	41.7	35.4 d
stem	41.7	58.3	83.3	83.3	66.7 b
stolon	91.7	91.7	100.0	100.0	95.8 a
Mean	30.0 c	38.3 bc	56.7 a	50.0 ab	43.7

Lso Detection - Late Season Infections





Germination Study



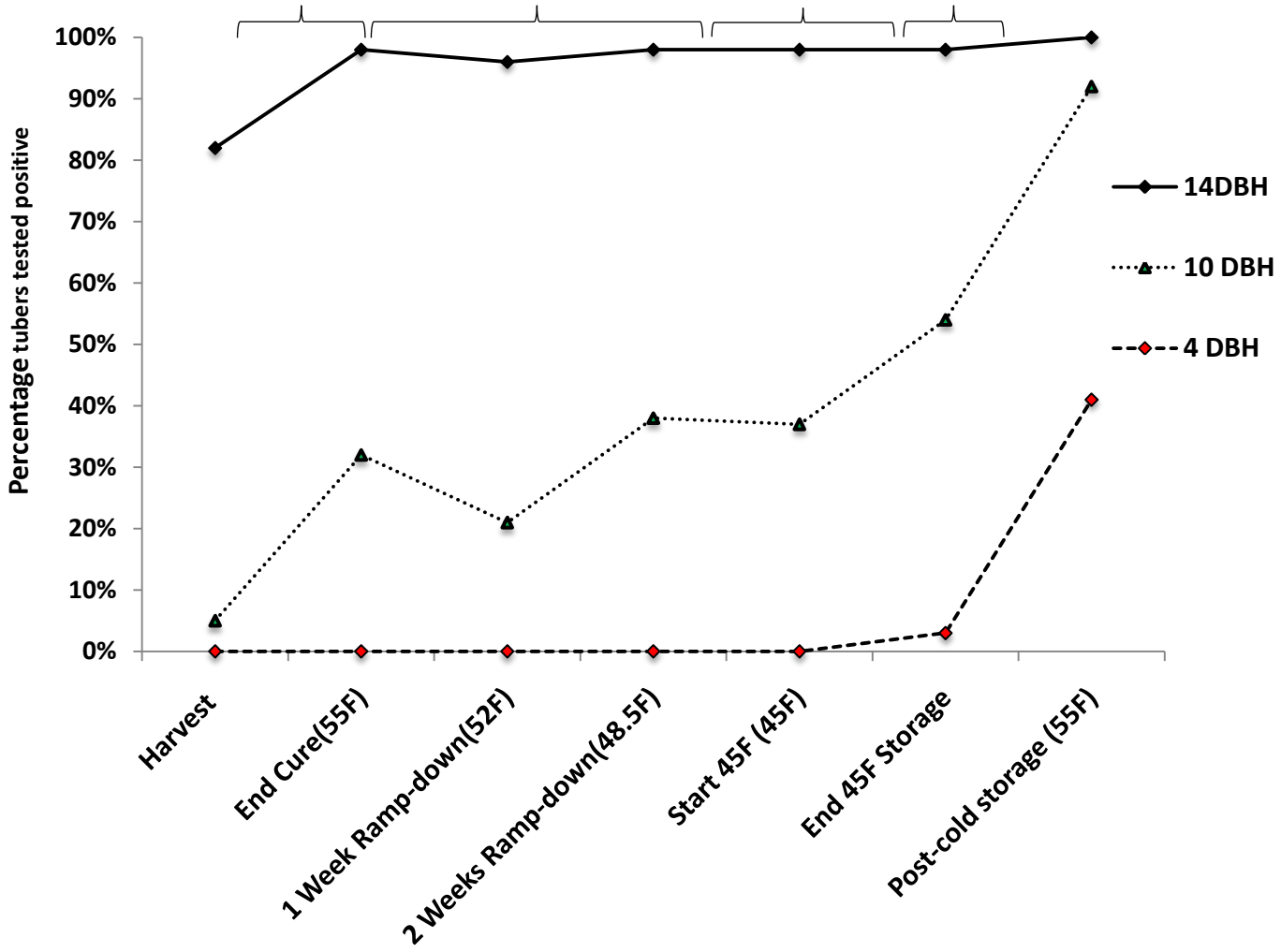
Since most of the potatoes infested 2 wk before harvest, and all those infested 1 wk before harvest, tested negative for the pathogen, why was there such a low percent emergence?

Late Season Infestation – Storage Study

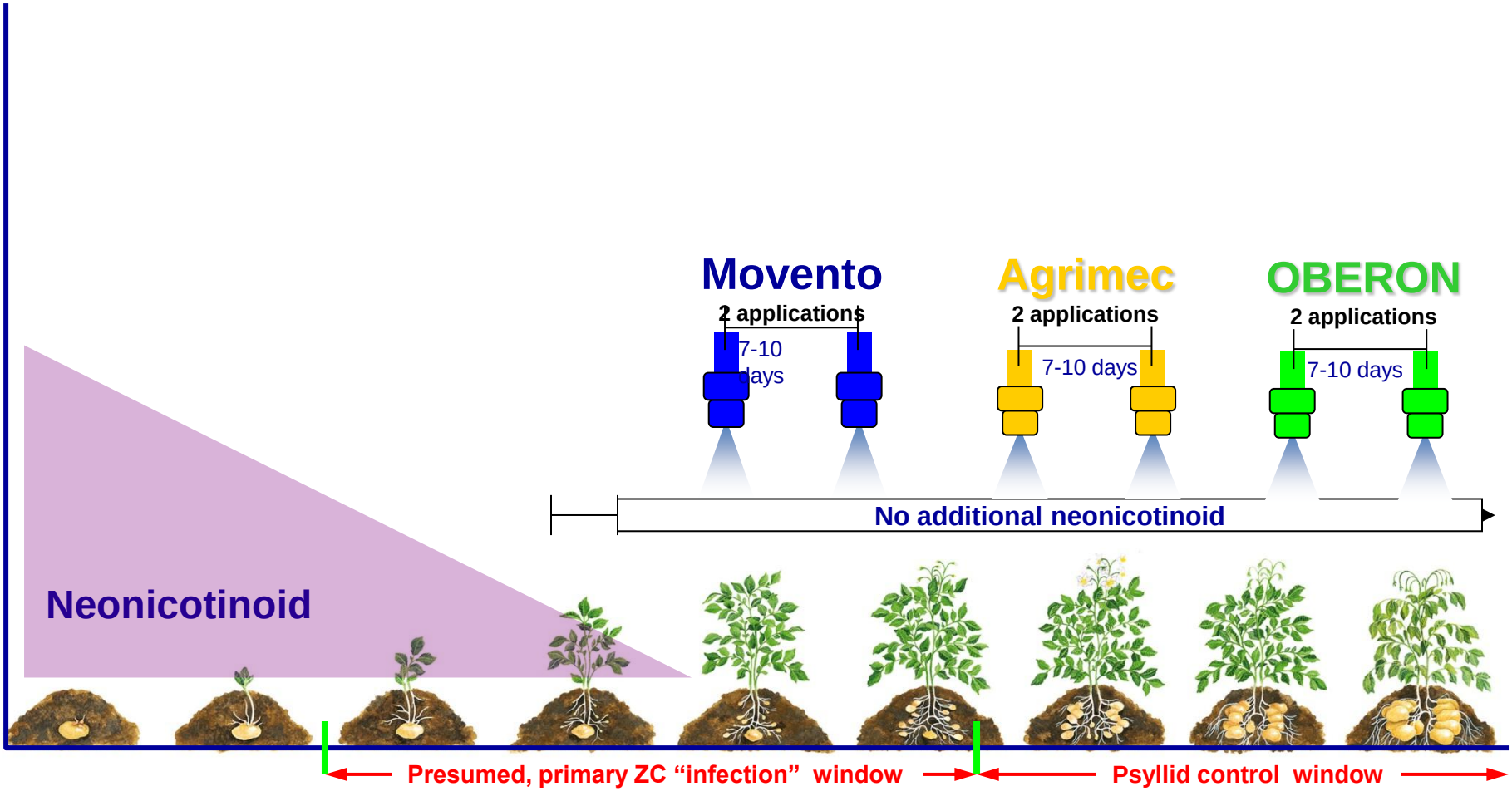
- Plants infested 1 or 2 weeks before harvest
- At harvest, sampled all tubers for Lso and then stored tubers at 40-42F
- After 2, 4, and 6 months tubers were removed from storage and sampled for Lso
- After sampling, tubers were placed at 72 F and then resampled for Lso at weekly intervals

Stolon attachment

Lso Development in Storage after Harvest



Best Management Practices for Potato Psyllid / Zebra Chip Management



Planting	Emergence	Stem formation	Main stem elongation	Tuber formation	Flower emergence	Flowering	Tuber development	Maturation Bulking-up	Senescence
0	10	20	30	40	50	60	70	80	90

Resistance to Insecticides

Resistance detected in current TX psyllid population (Tex 12)!

Measures of lethal imidacloprid doses (mg a.i.). RR_{50}=3.4, RR_{90}=6.4

	LC_{50}	SE	CI	LC_{90}	SE	CI	Slope	SE
Tex06	21.7	0.05	18.7-21.7	130.2	0.08	83.5-98	2.23	0.10
Tex12	74.8	0.06	66.6-84.0	839.7	0.14	558.8-1262.1	1.45	0.16

Reflects “low tolerance” approach used in most grower fields

Zebra Chip Research Priorities

- **Improved understanding of host/pathogen/vector interactions**
- **Development of a disease risk assessment model – pathogen/vector ecology and epidemiology**
- **Development of an action threshold for insecticide applications – better monitoring will be required**
- **Better pesticide management to prevent/slow vector resistance**
- **Identification and development of genetic resistance and resistant cultivars**
- **Late season infections, pathogen detection and Lso/ZC development in storage**

Zebra Chip Education and Extension Priorities

- **Grower education and training, with regard to disease and vector identification**
- **Grower training in disease management options and risks of over applying insecticides**
- **Continuation of annual ZC reporting session**
- **Development, testing and adoption of mobile applications that growers can use for information retrieval and decision support**
- **Continuation of the ZC Website as the primary source of information on all aspects of ZC**


Thank You, Questions?