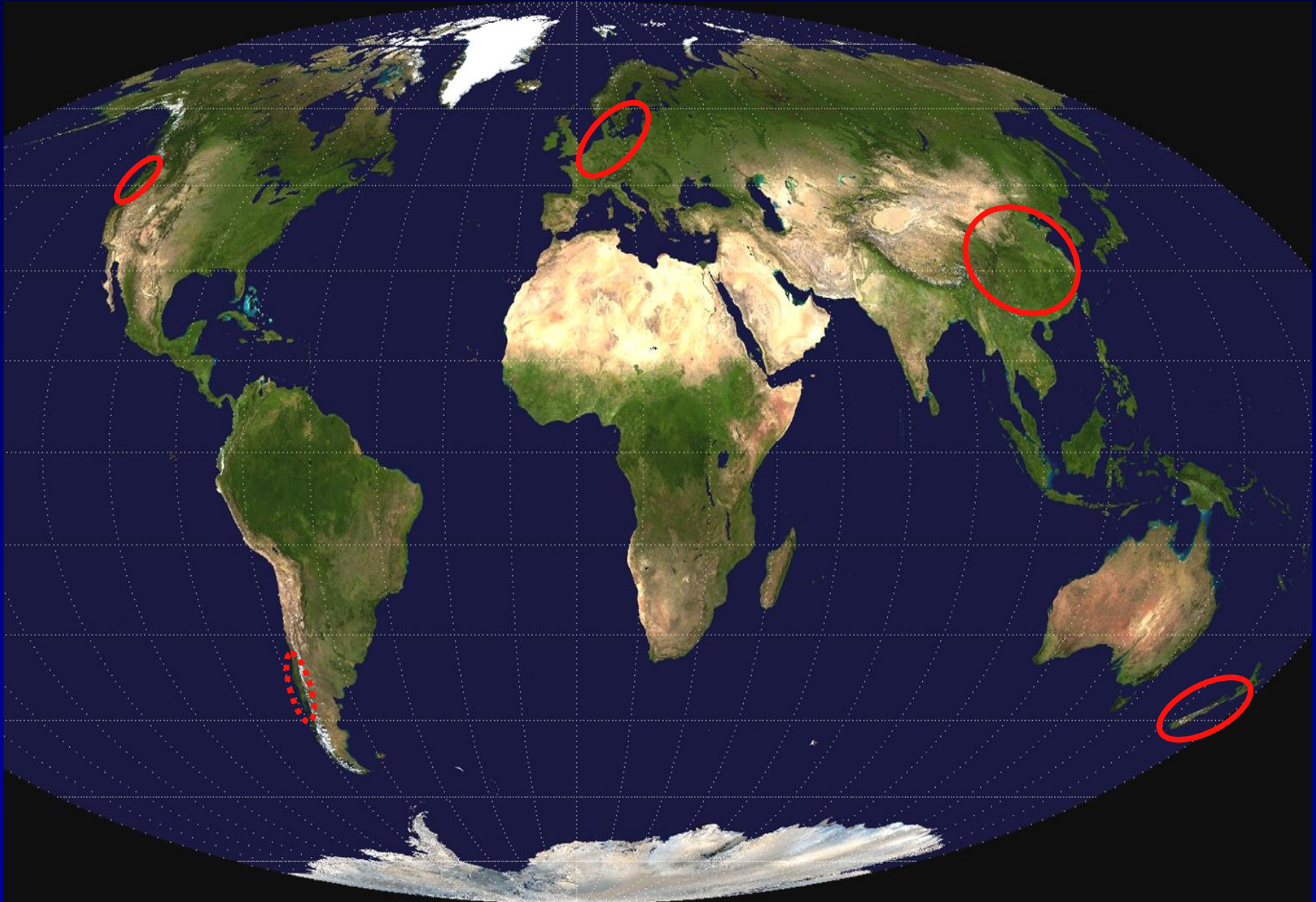


# Spinach Seed Production in the Pacific Northwest USA



**2018 International Spinach Conference, Murcia, Spain  
14-15 February 2018  
Lindsey du Toit, Washington State University**

# Global Spinach Seed Production



# Global Spinach Seed Production

Country	Estimated hectares (2016-2017)
Denmark	>7,000
USA (OR, WA)	1,500-2,000
Holland	500
Italy	250
France	220
New Zealand	400
Chile	20
China (Asian markets)	LOTS! (mostly Asian types, including <i>Tetragonia</i> spp.)



1 ha hybrid  
spinach  
seed crop



~10 ha baby  
leaf spinach  
crop

# Spinach Seed Production in USA





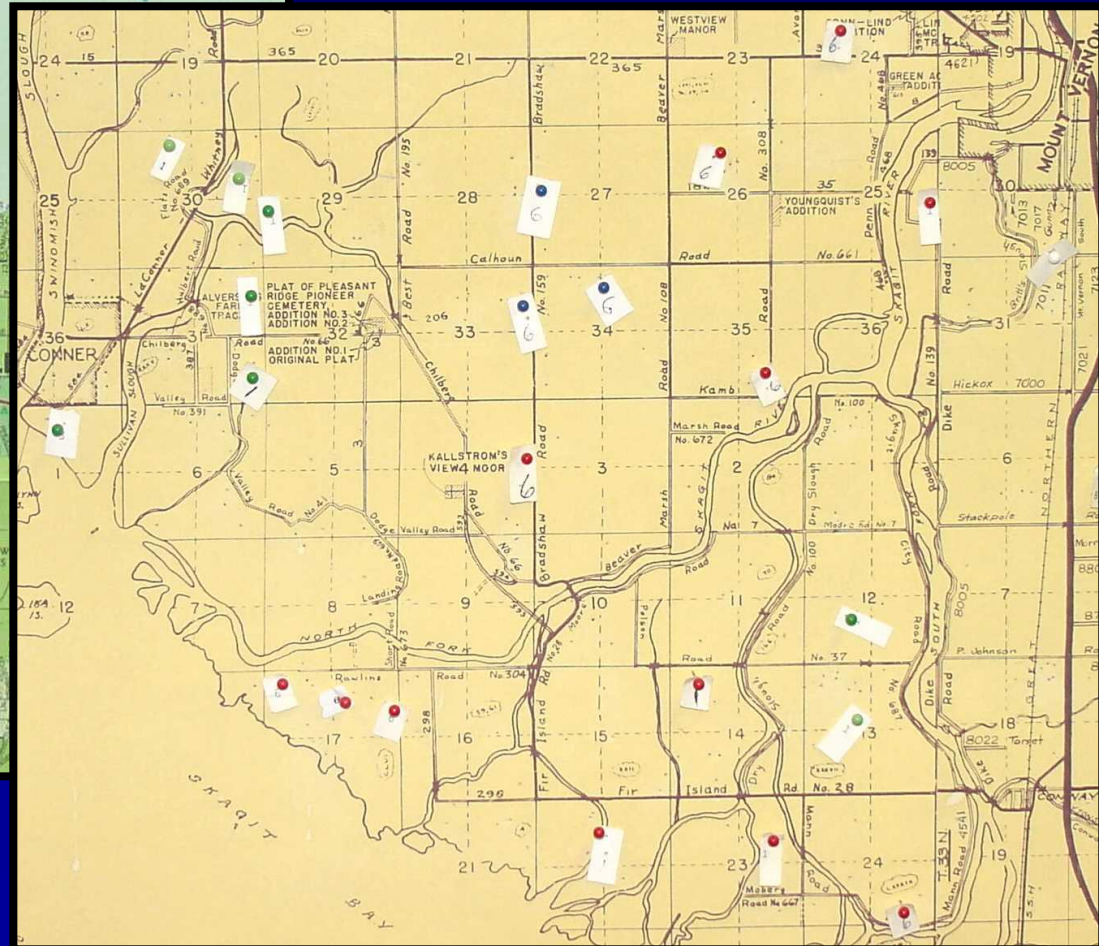
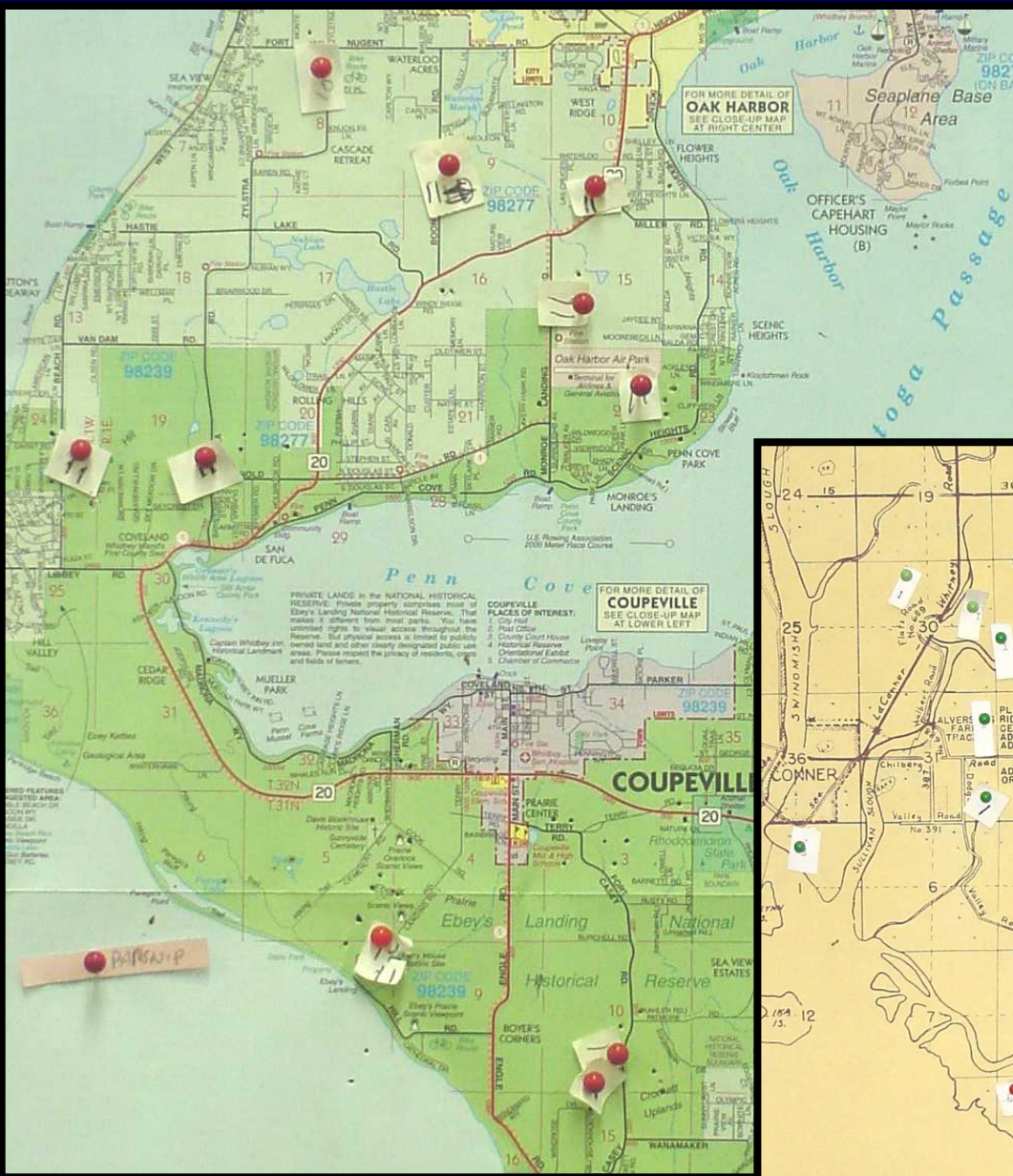
**Crop Profile for Spinach Seed Crops in Washington State**

<http://www.ipmcenters.org/cropprofiles/docs/waspinachseed.html>

**Principles & Practices of Organic Spinach Seed Production  
in the Pacific Northwest. Organic Seed Alliance.**

[www.seedalliance.org](http://www.seedalliance.org)

# Seed crop isolation



# Criteria for the spinach seed industry

- trueness-to-type (genetically)
- seed germination
- seed vigor
- pathogen-free seed
- no weed seed/debris
- cost of production - US\$, labor
- resistance to races of downy mildew



# Grower expenses/returns

- by contract only, company dependent
- expenses:
  - WA: ~\$1,400-\$1,600/acre
  - OR: higher (irrigation needed)
- seed production costs increased 4x
- price of competing crops
- growers paid: \$1.80-\$2.00/lb seed
- yields variable based on parent lines
  - earlier bolting lines similar in DK & US
  - later bolting lines less yield in US vs. DK

March-April



Plow, mulch, fertilize; then limestone applied/incorporated



RoNeet (cycloate) herbicide applied/incorporated

Late Mar.-mid-May: Planting, in-furrow fertilizer, granular insecticide



# Planting spinach stock seed

- Treated seed: mefenoxam + thiram or Farmore 300 (mefenoxam + fludioxonil + azoxystrobin); now also thiophanate-methyl or thiabendazole (Fusarium and Verticillium wilts)
- Insecticides: craneflies, springtails
  - carbofuran no longer used
- Male:female ratio, staggered planting male rows
- OP crops = smaller-scale, organic seed crops
- Stock seed priming:
  - cold imbibing to change daylength response
  - nicking of male & female rows
  - reduce % inbred seed
  - cannot store seed >3 months



Cultivate

Spinaid  
(phenmedipam)  
at 2-4 true leaf  
stage



Other  
herbicides:  
Nortron  
(ethofumesate)  
Dual Magnum  
(S-metolachlor)  
Fusilade  
(fluazifop-P-  
butyl)  
Asulox  
(asulam)

Cultivate, side-dress (27-0-0) or top-dress ( $\text{CaNO}_3$ )

Application of a pesticide to a crop or site that is not on the label is a violation of pesticide law and may subject the applicator to civil penalties up to \$7,500.

In addition, such an application may also result in illegal residues that could subject the crop to seizure or embargo action by WSDA and/or the U.S. Food and Drug Administration.

It is your responsibility to check the label before using the product to ensure lawful use and obtain all necessary permits in advance.



Rogue off-types & males in female rows: 3-7x/crop



Fungicide applications: leaf spots, downy mildew;  
early anthesis, preceding rains

# Fusarium Wilt

*Fusarium oxysporum* f. sp. *spinaciae*





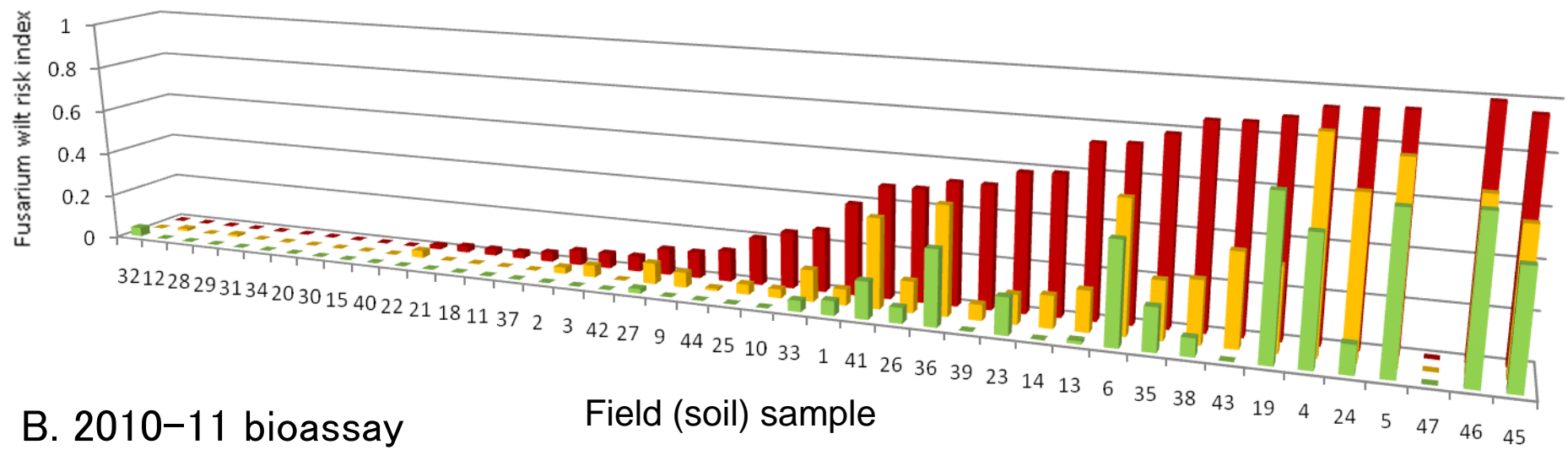
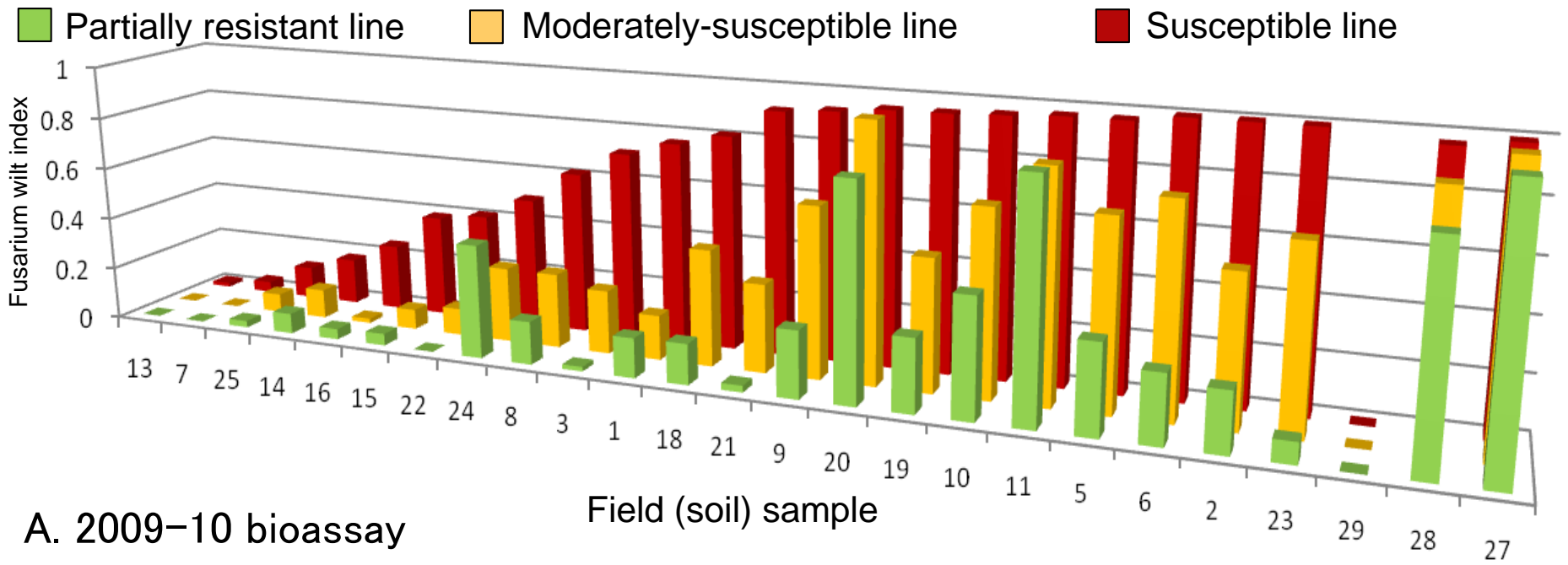
# Spinach Fusarium Wilt Soil Bioassay & Parent Line Screen

Offered every winter since 2009-2010, >350 fields tested  
\$200/field, \$75/parent line

Gatch and du Toit. 2015. Plant Dis. 99:512-526.



# Risk assessment: Spinach Fusarium wilt



# Verticillium wilt



AUG 19 2003

# Leaf spot fungi

Photo by M.L. Derie

*Cladosporium  
variabile*

*Stemphylium  
botryosum*



# Downy mildew



# *Cucumber mosaic virus*

Influence of parent line on  
rate of seed transmission



# Aphids (vector viruses)



Root aphids



Leafminer



Thrips



Lygus bugs



**Others:** springtail, crane fly, cutworm, armyworm, looper



# Windrowing



# Combining

Photos courtesy of Jensen Seeds

Spiral separator



Color sorter



Gravity table & sizer

# Integrated spinach seed crop disease management in the PNW USA

- Rotation of 10 to >15 years, bioassay for risk assessment
  - for Fusarium wilt, Verticillium wilt
  - resistance of parent lines in previous crops
  - biofumigant cover crops or soil amendments
    - agricultural limestone: 1-2 tons/acre, several years
- Clean stock seed:
  - assay for fungi & CMV, seed treatment combinations
- Susceptibility of parent lines
- Orientation of rows in primary wind direction
- Fertilizers: ammonium vs. urea, foliar feeds
- Fungicides: timing (anthesis & rains), modes of action, organic & conventional
- Scouting & rogueing, accurate diagnoses
- Management of crop residues & volunteers
- Testing of harvested seed (quality and health assays)