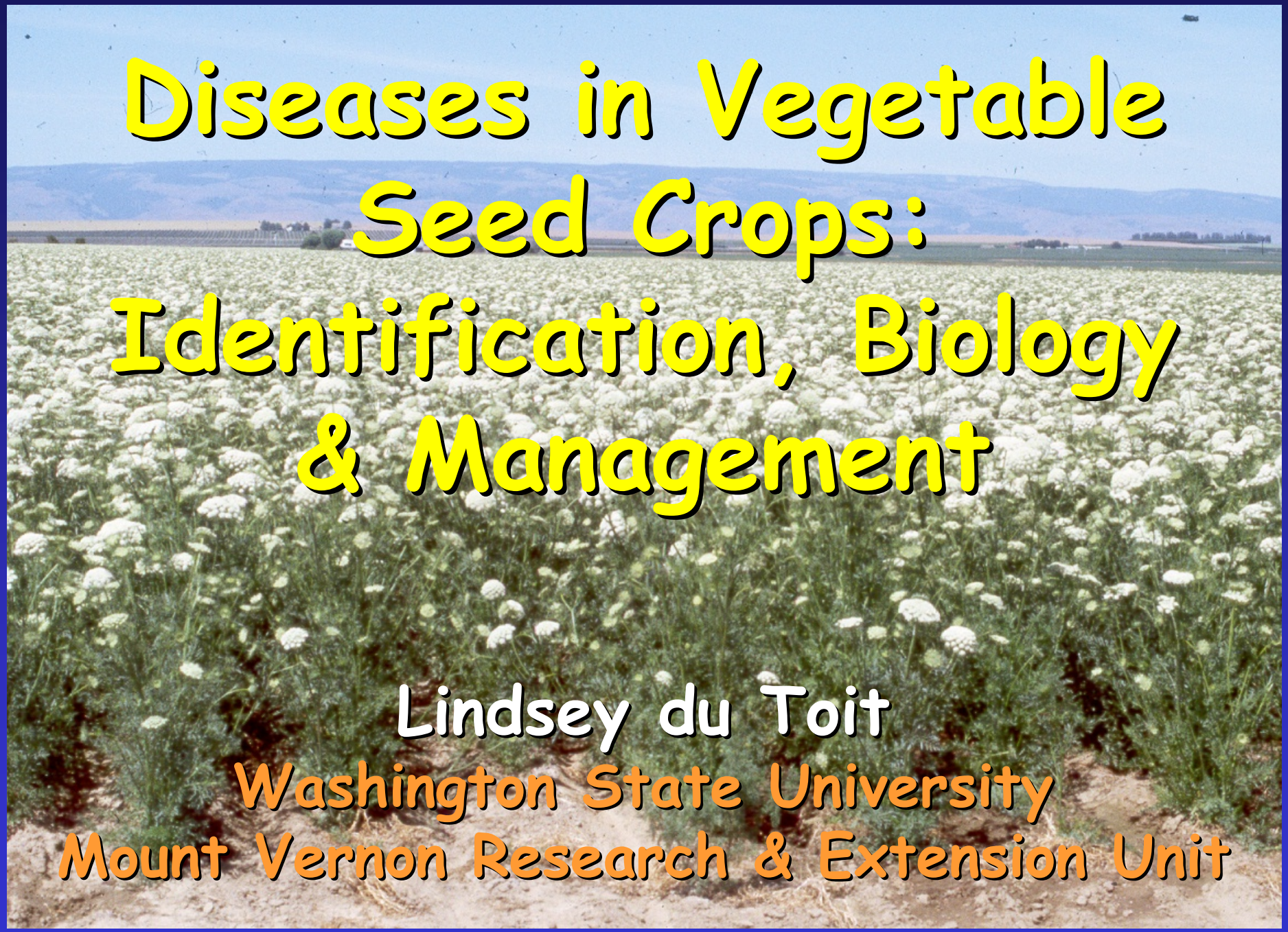
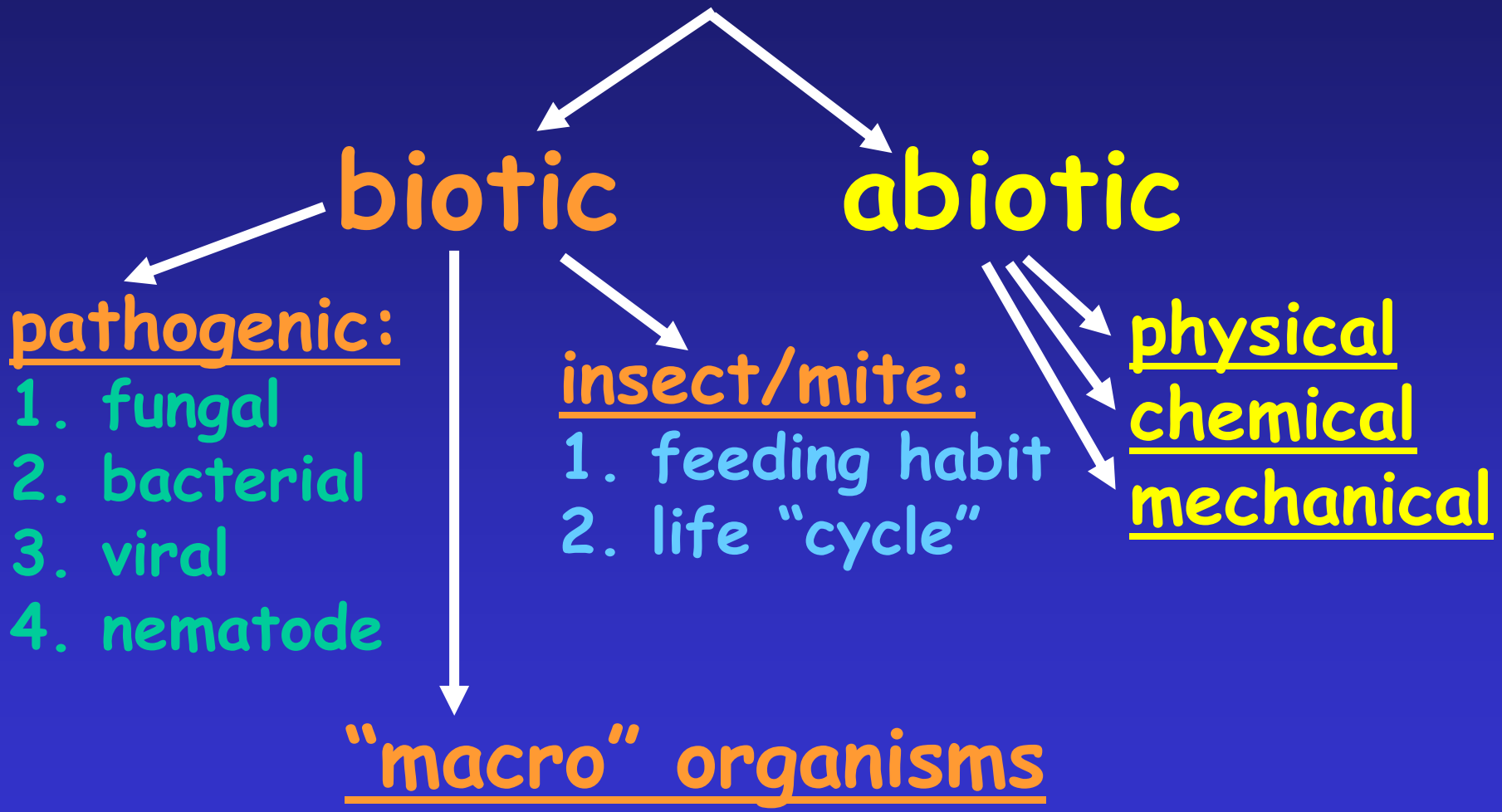


Diseases in Vegetable Seed Crops: Identification, Biology & Management

Lindsey du Toit
Washington State University
Mount Vernon Research & Extension Unit

diagnosis of plant problems

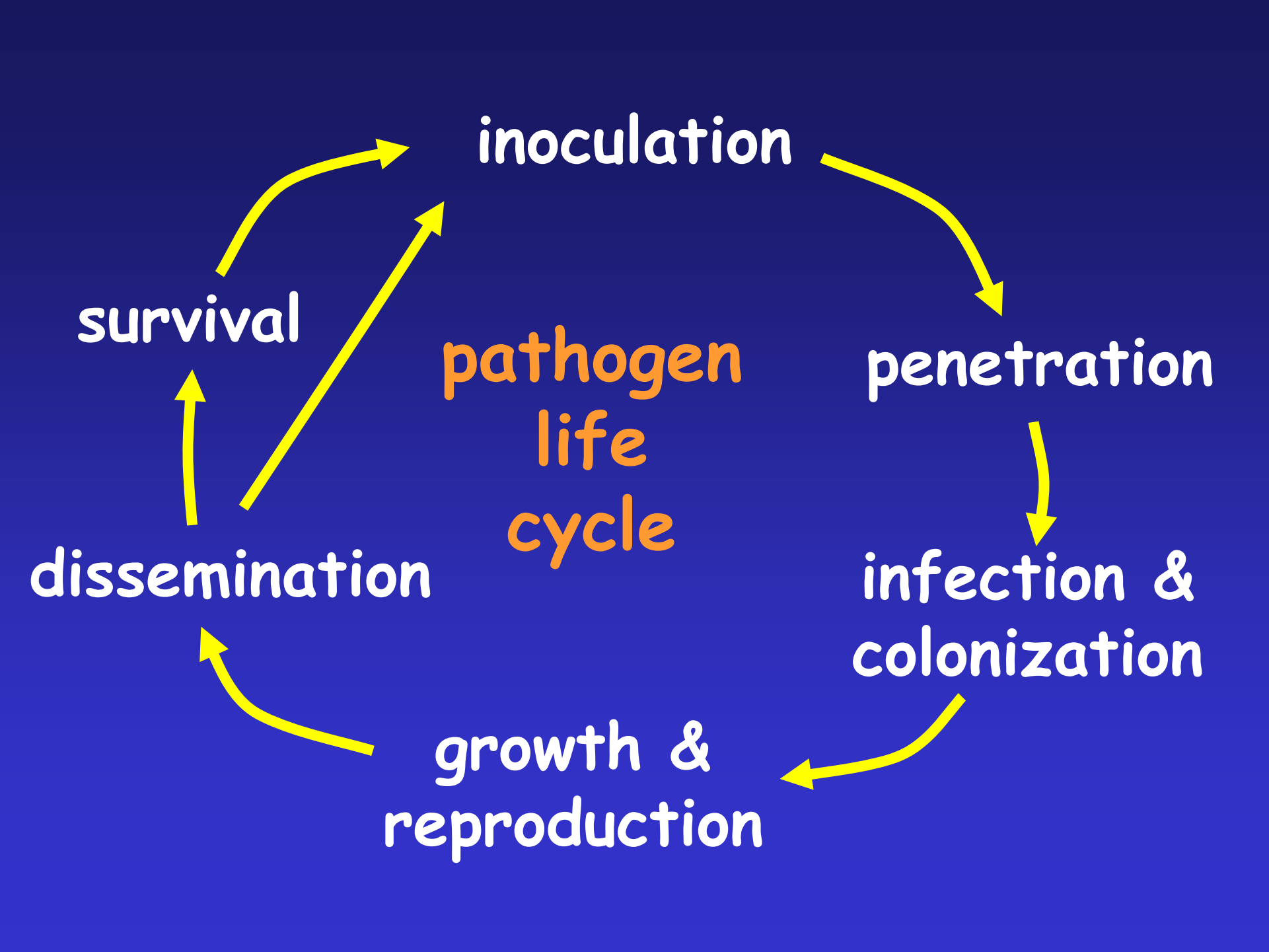


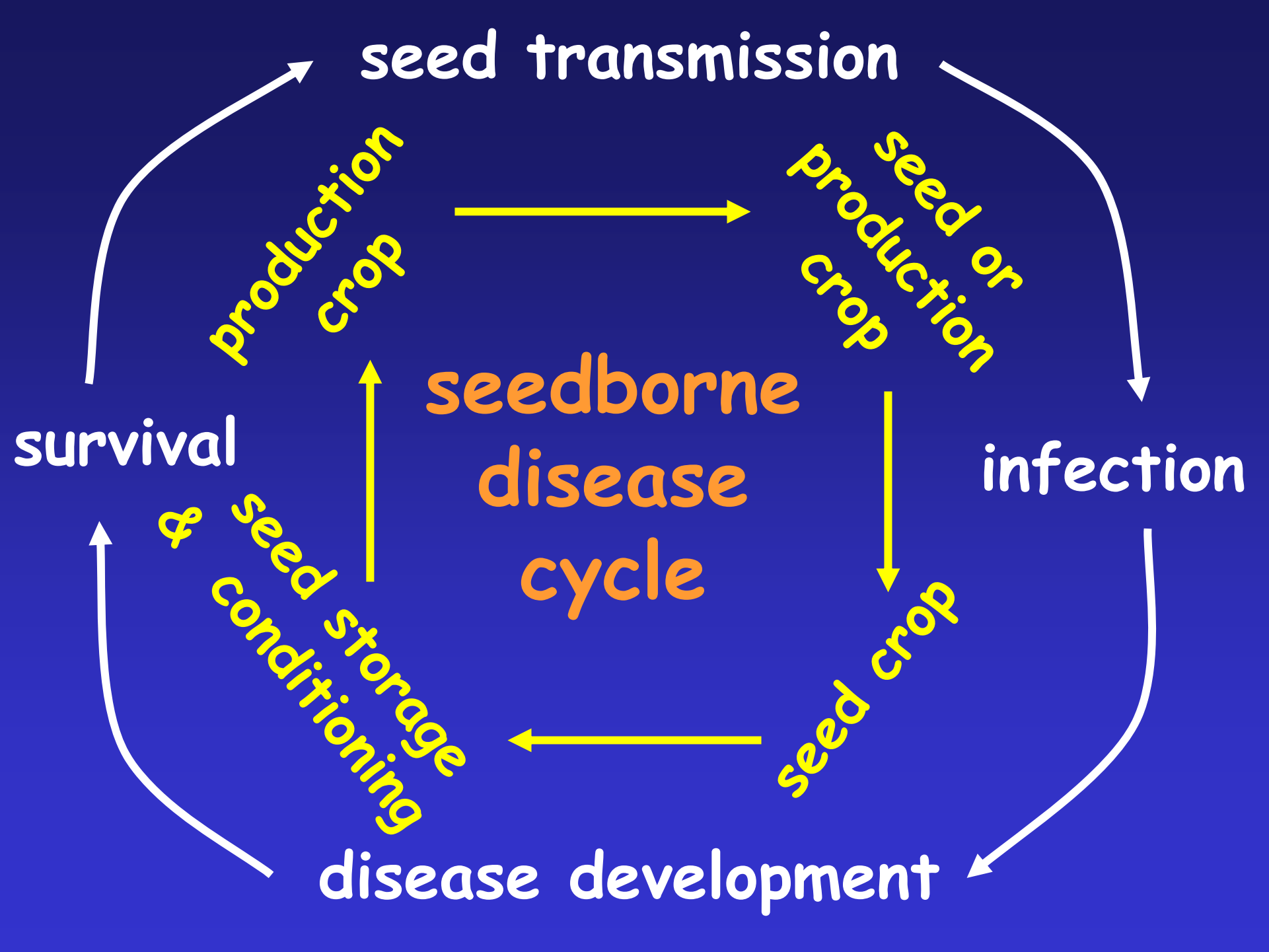
Effects of diseases of vegetable seed crops

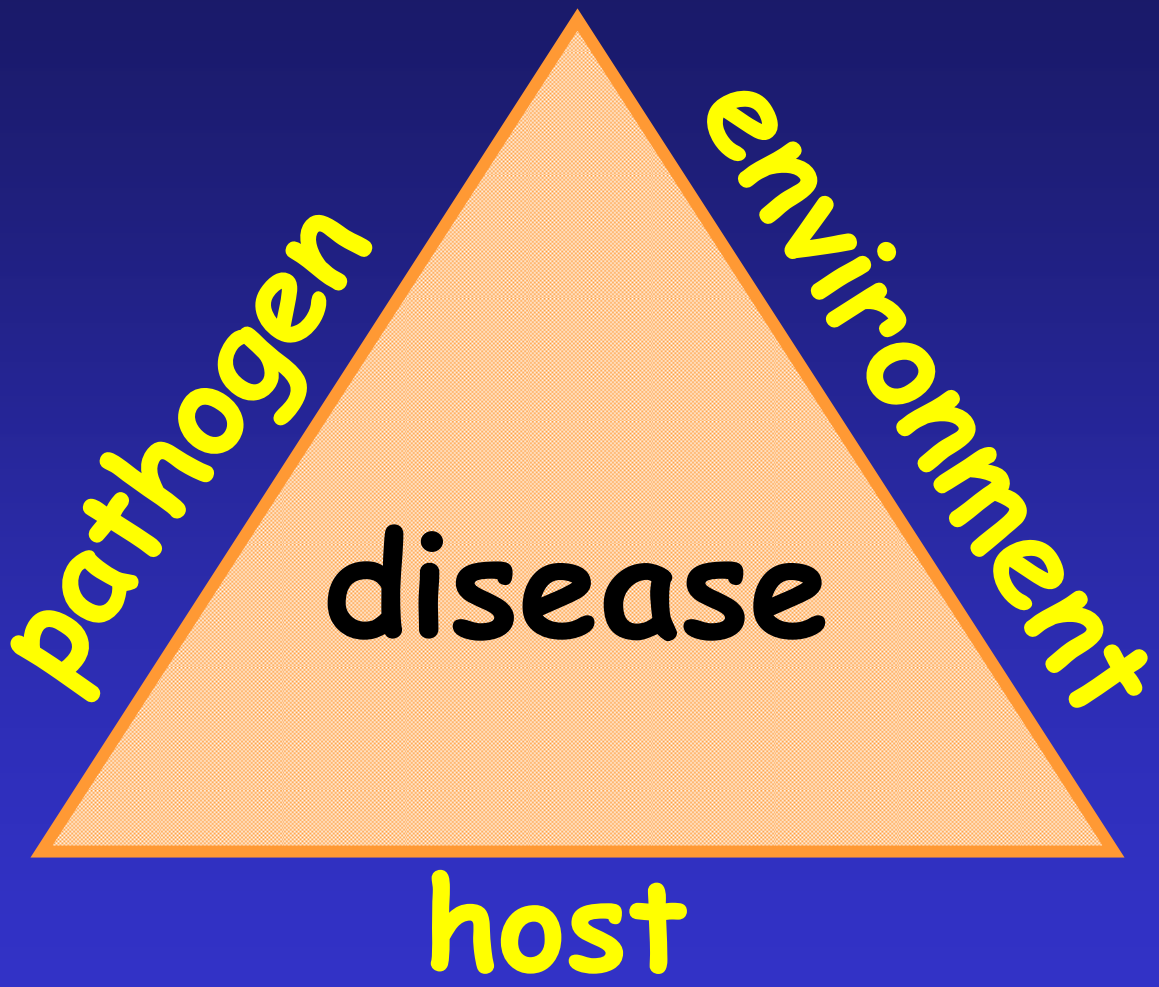
- yield loss
- infection of harvested seed
- reduction in seed germination & vigor
- seed transmission of pathogen(s) to new crops

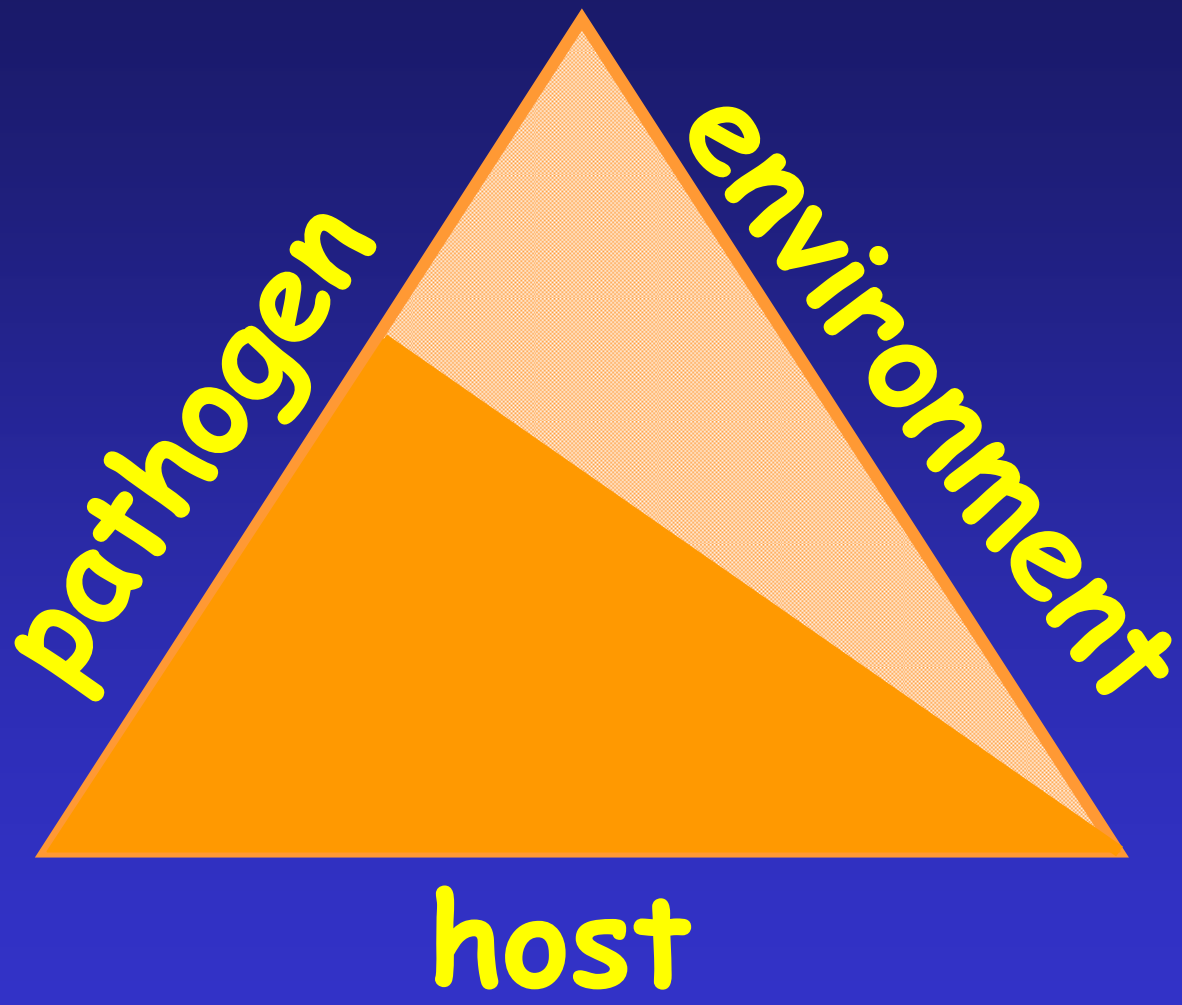
Classes of seedborne microorganisms

1. Infected seed = primary inoculum source. If seed infection is controlled, the disease is controlled
2. Important crop pathogen, but infected seed = minor source of inoculum
3. Seedborne microorganisms never demonstrated to cause disease
4. Pathogens that infect seed in fields or in storage, and reduce seed quality


inoculation
penetration
infection & colonization
growth & reproduction
dissemination
survival
pathogen life cycle


seed transmission
production crop
seed or production crop
survival
seedborne disease cycle
infection
seed storage & conditioning
seed crop
disease development


pathogen
environment
disease
host


pathogen
environment
host

Disease management in seed crops

- cultural practices
- chemical applications, seed treatments
- disease resistance

Disease management in seed crops: Cultural practices

- Crop rotation
- Elimination of alternative hosts
- Destruction of inoculum in the field
- Control of insect vectors
- Irrigation practices
- Planting practices
- Ventilation of seed crops
- Fertilizer programs
- Transplanting
- Harvesting
- Geographical location

Disease management in seed crops: Cultural practices

Crop rotation

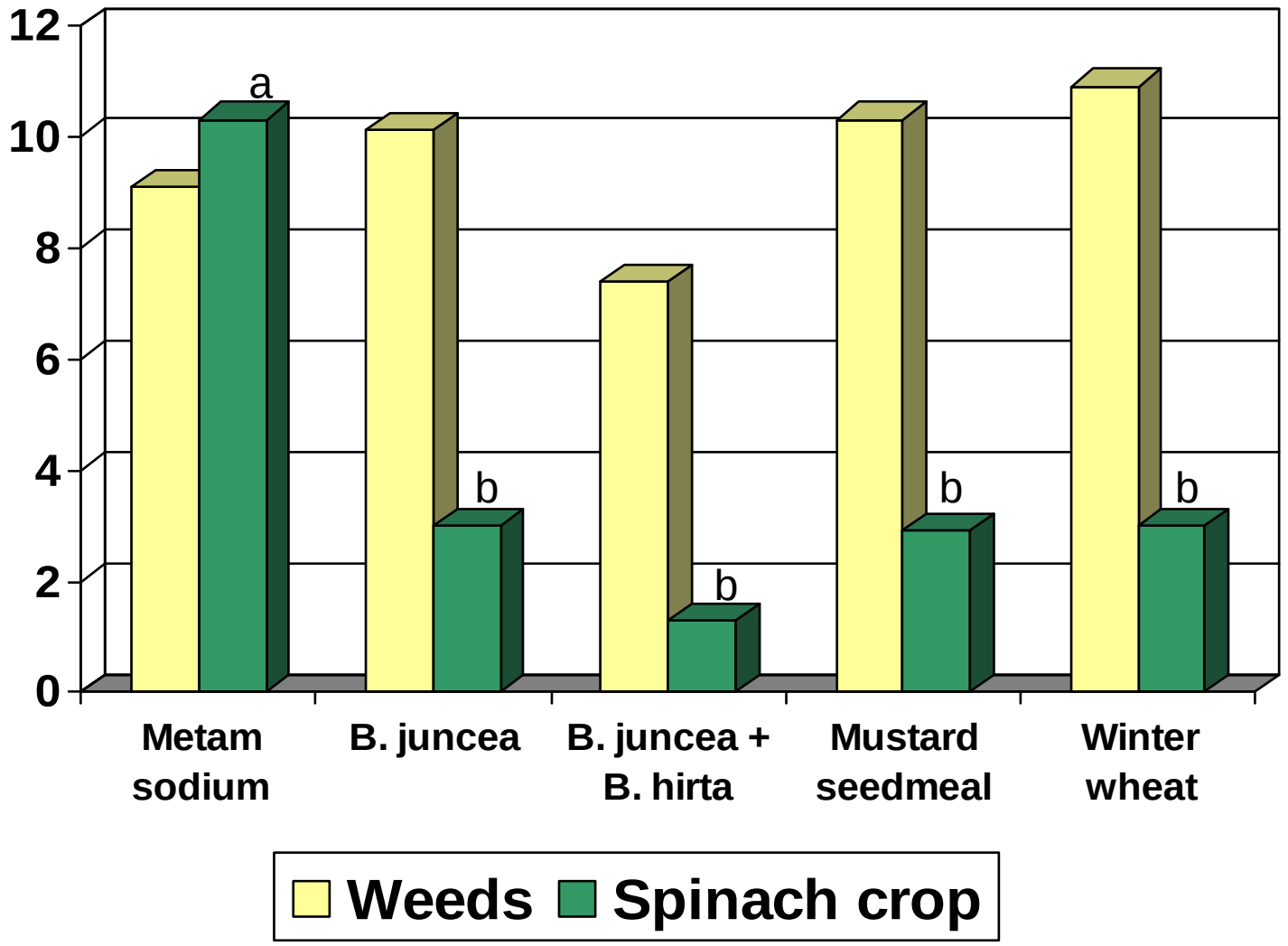
- non-host, resistant, or 'antagonistic' crops
- duration dependent on pathogen host range,
  foliar vs. soilborne pathogens,
  longevity of inoculum survival,
  resistance of cultivar or parent lines
  cultural practices, etc.
- be aware of asymptomatic hosts

Elimination of alternative hosts

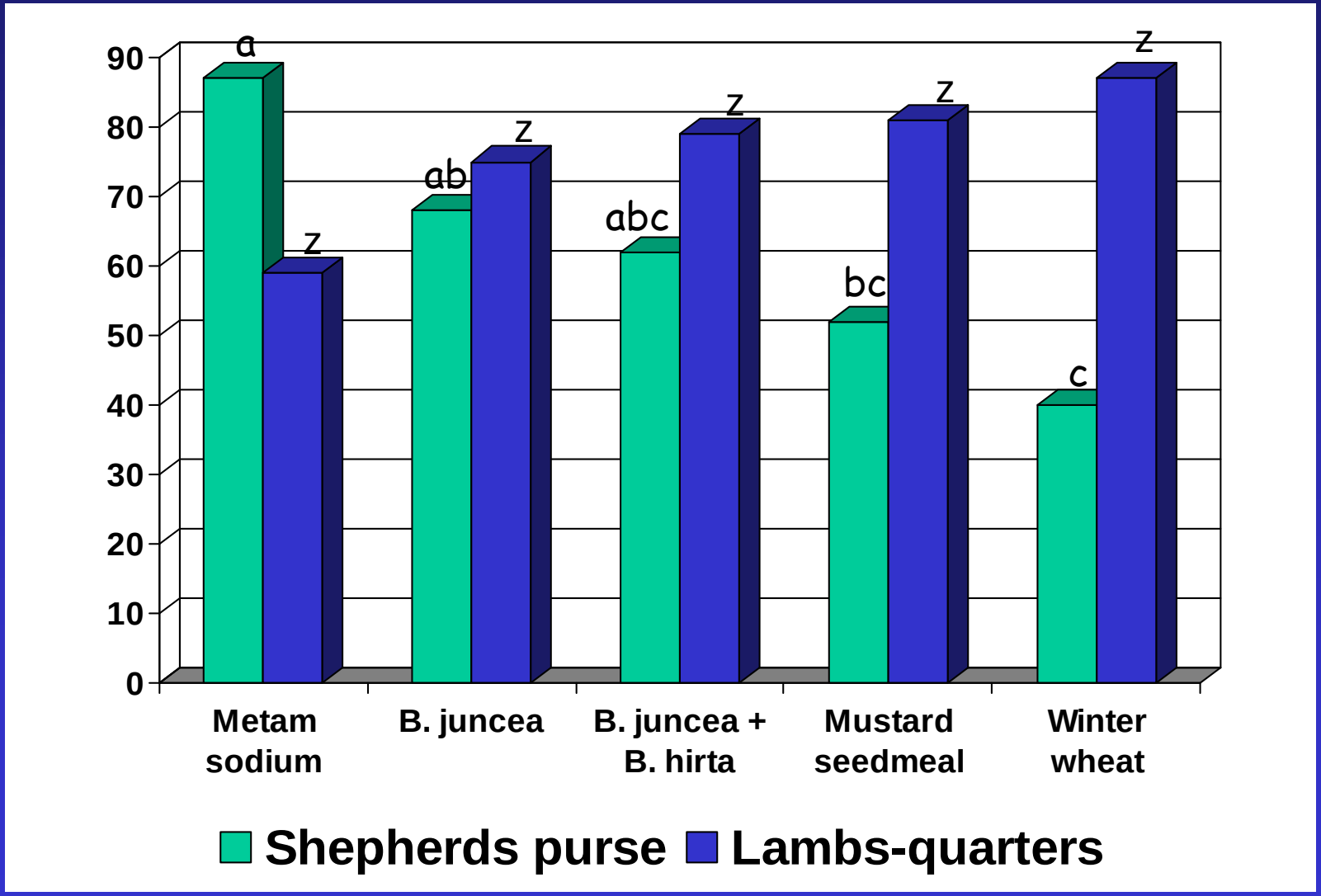
- weeds
- volunteers
- adjacent crops

Evaluation of mustard vs. winter wheat cover crops in spinach seed production

Biomass (g/0.15 m^2) of weeds and spinach seed crop on 6/13/03 following incorporation of mustard cover crops



% weed control of shepherd's purse & lambsquarters on 6/13/03, using mustard cover crops prior to spinach seed production



Disease management in seed crops: Cultural practices

Destruction of inoculum in the field

- remove, or reduce, amount of infected debris or remaining seed after harvest
- reduce inoculum of soilborne pathogens

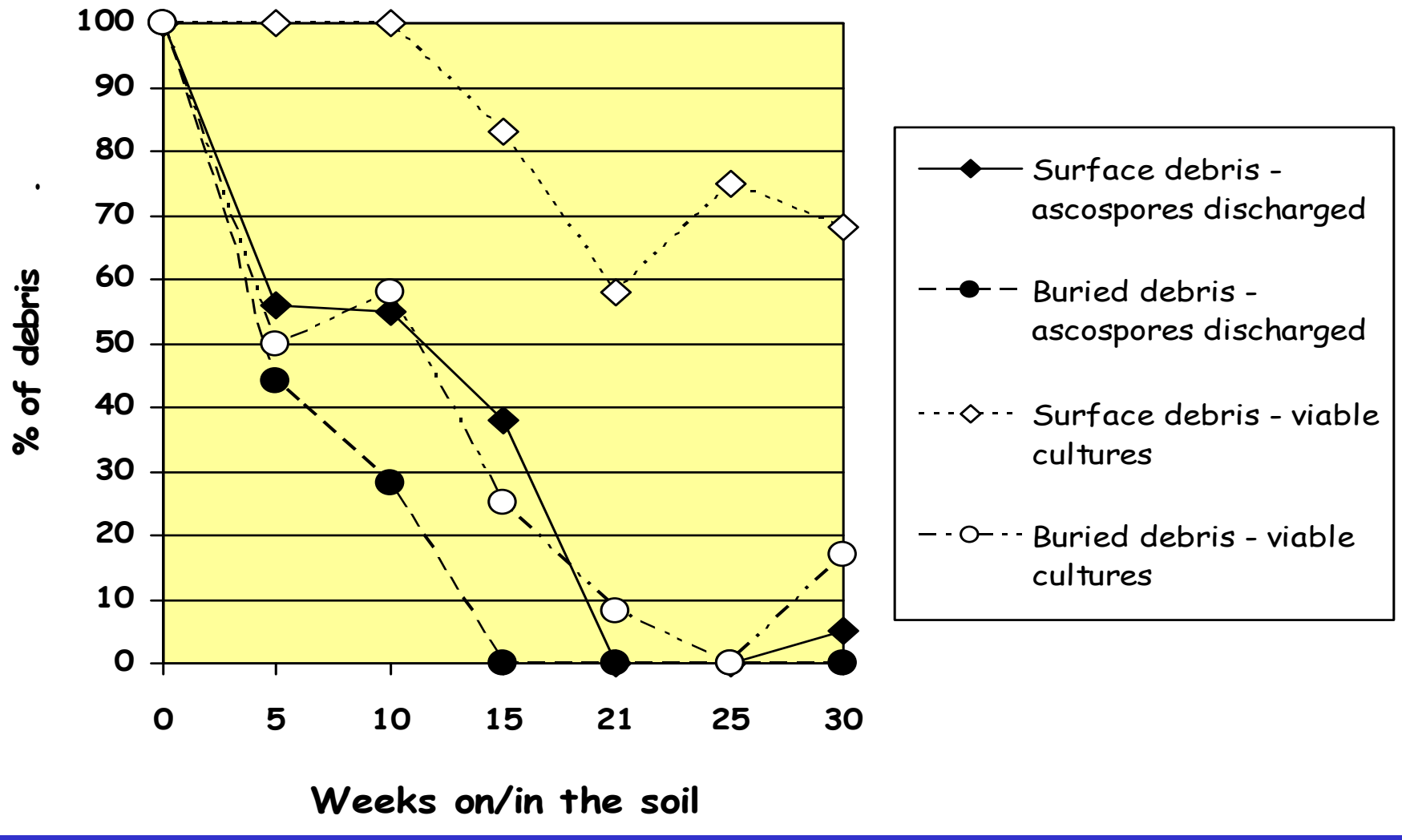
- burn stubble/debris
- vacuum fields
- fumigation (synthetic, biofumigation)
- soil solarization
- incorporate infested debris into the soil

Overwintering of spinach leaf spot fungi in western Washington

Cladosporium variabile on volunteer spinach

Stemphylium botryosum on spinach seed stalk debris

Survival of *Stemphylium botryosum* on spinach debris: Surface vs. buried debris

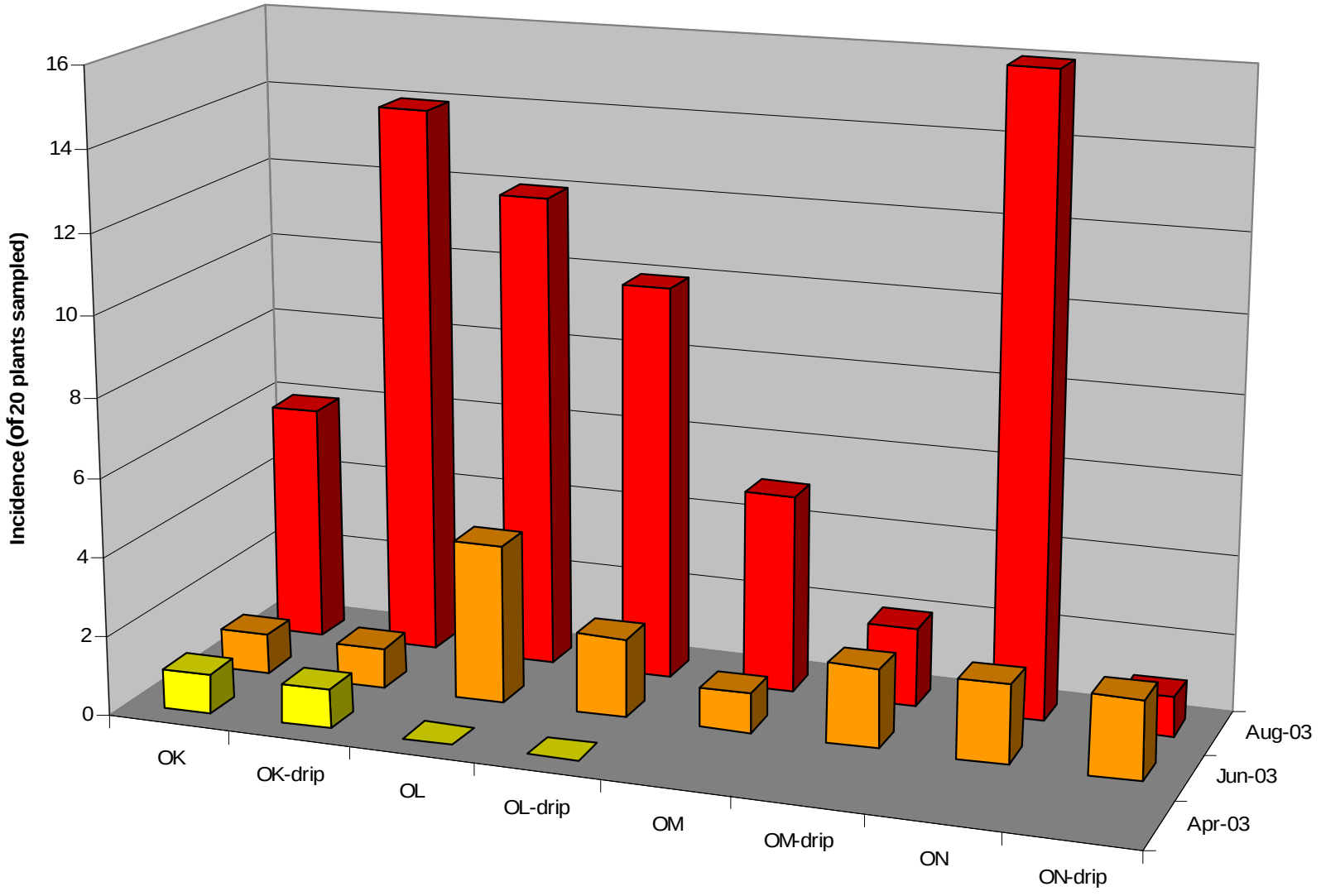


Disease management in seed crops: Cultural practices

Irrigation practices

- reduce duration of leaf wetness, splash dispersal, relative humidity
- e.g., drip vs. furrow vs. overhead irrigation
- economics, practicality?
- timing of irrigation

Incidence of plants on which *Xanthomonas campestris* pv. *carotae* was detected in drip vs. overhead-irrigated sections of 4 carrot seed crops in central Oregon, 2002/03



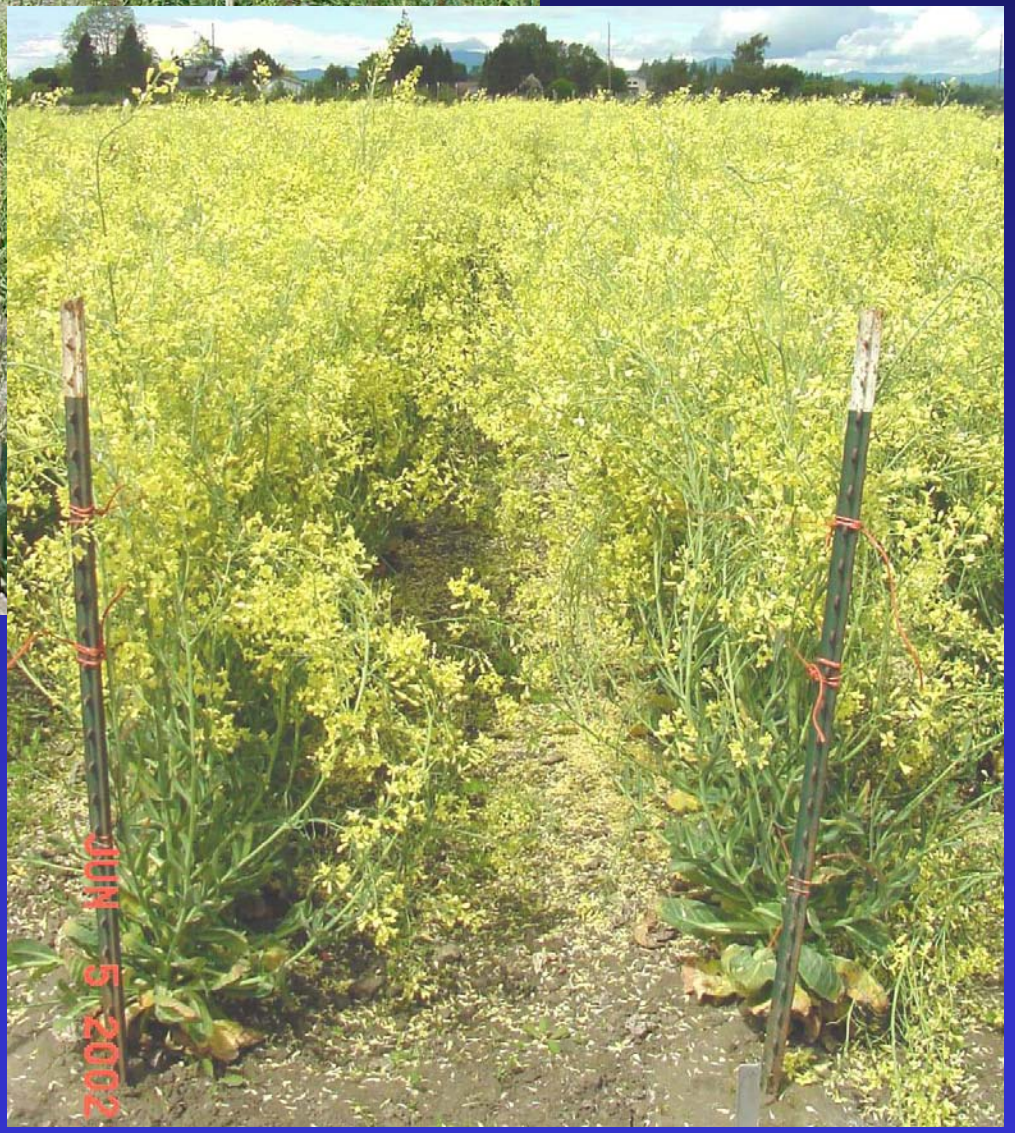
Disease management in seed crops: Cultural practices

Planting practices

- planting date selected to escape inoculum
  - insect vectored pathogens
  - pathogens that don't overwinter in the region
- planting date selected for unfavorable conditions for pathogens &/or favorable for crop
- row spacing, plant spacing
- row orientation

Ventilation practices

- thinning
- canopy management for maximum air circulation



Brassica seed crop ventilation through row orientation, row spacing, & staking/tying

Disease management in seed crops: Cultural practices

Transplanting & hygiene

- avoid mechanical injury during transplanting
- avoid dipping transplants in water
- mechanical transmission of pathogens by workers:
  - *Septoria apiicola* in celery
  - *Xanthomonas campestris* pv. *campestris* in cabbage
  - *tobacco mosaic virus* (TMV) transmission on hands of smokers

Disease management in seed crops: Cultural practices

Geographical location

- continental level: grow seed crops in environments unfavorable for disease
  - bean seed in ID & CA to avoid bacterial blights & anthracnose
  - pea seed ID, WA, CA to avoid *Pseudomonas pisi* & Ascochyta blight
  - crucifer seed in WA to avoid blackleg & black rot
  - sweet corn seed in ID & WA to avoid Fusarium ear rots
- local level: avoid frost pockets, areas prone to fogs or dews

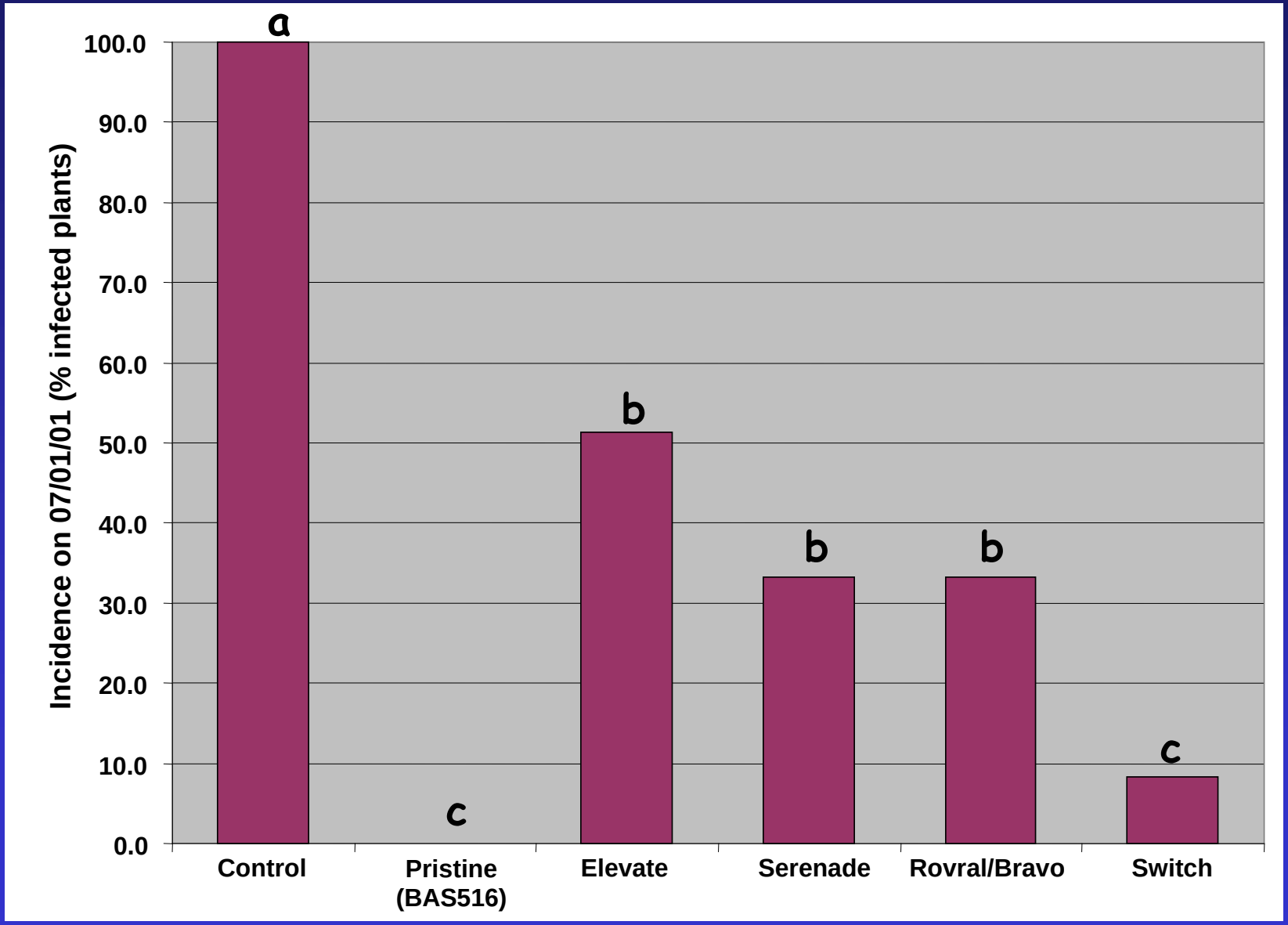
Disease management in seed crops: Chemical applications & seed treatment

- organic & biological materials
  - e.g., sulfurs, coppers, Serenade, AQ10, Contans, …
  - 2002 Plant Health Progress article by McSpadden Gardener and Fravel
  - consistency, niche environments?
  - potential phytotoxicity
- natural plant products
  - oils, plant extracts, compost teas, …
  - reliability, consistency?
- bicarbonate fungicides
  - powdery mildews

2000/01 Brussels sprouts seed crop fungicide trial

White mold (*Sclerotinia sclerotiorum*)

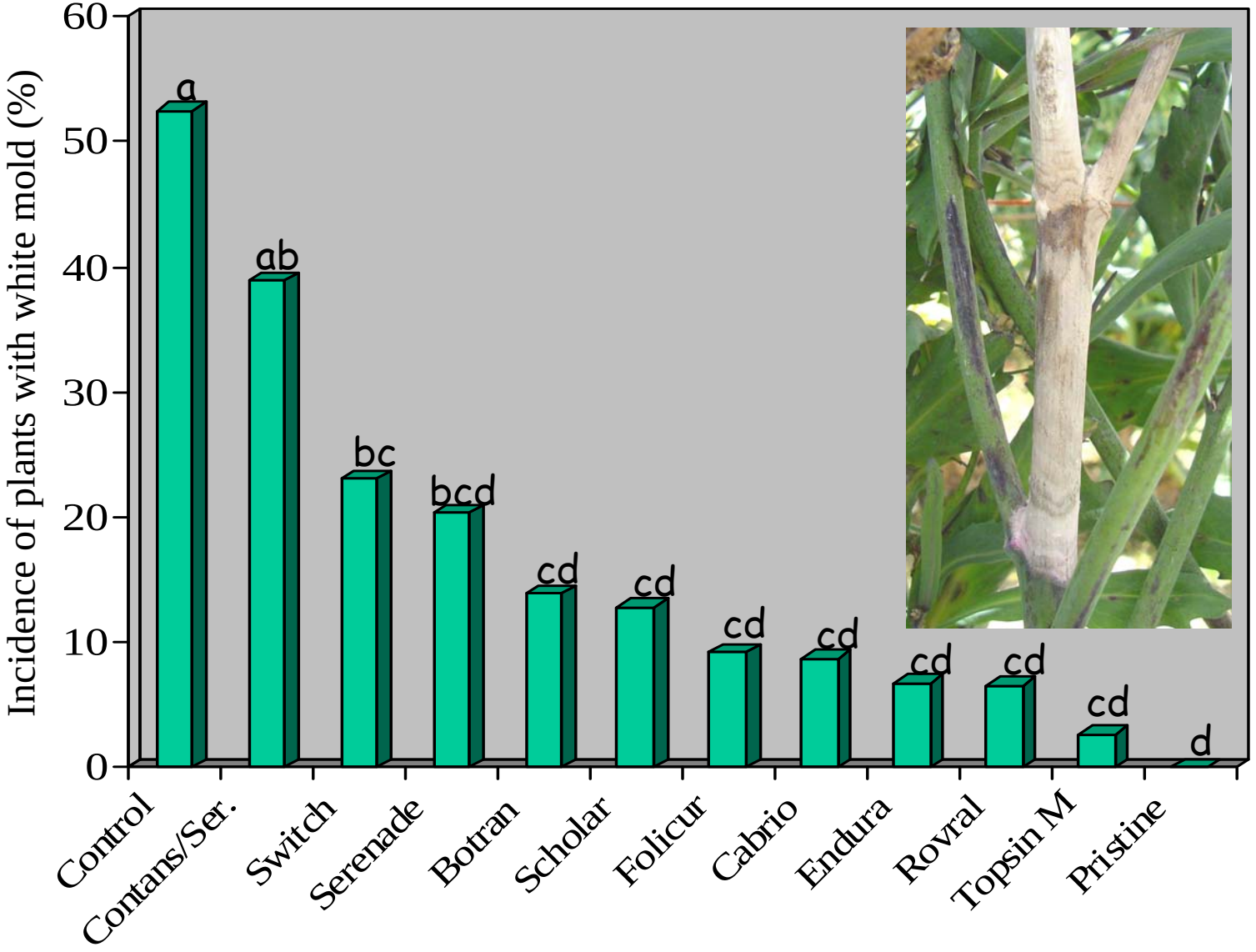
du Toit & Derie, 2002. Fungicide & Nematicide Tests 57:V013



2002/03 Cabbage fungicide trial

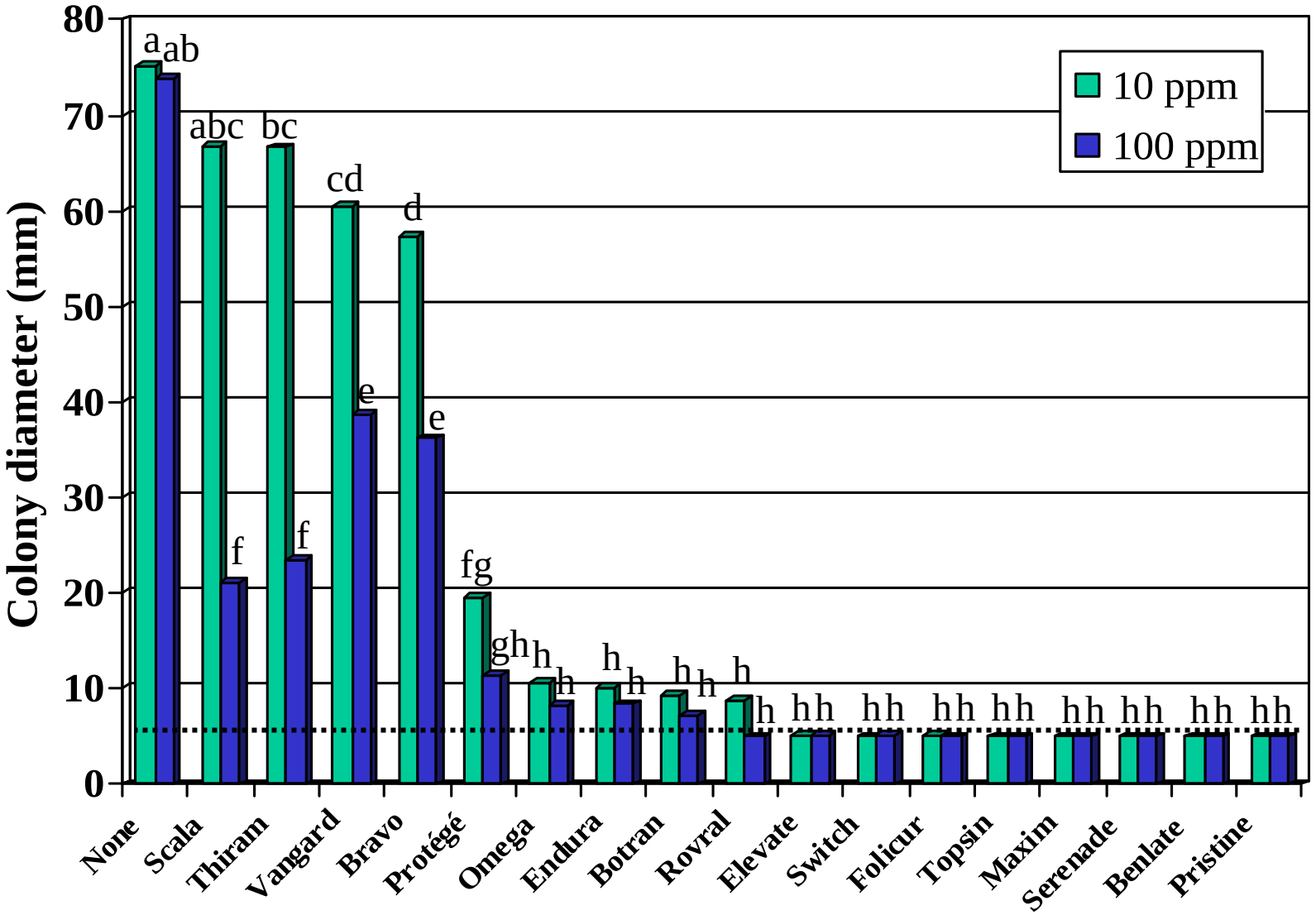
White mold (*Sclerotinia sclerotiorum*)

du Toit & Derie, 2004. Fung. & Nem. Tests 59:*submitted*

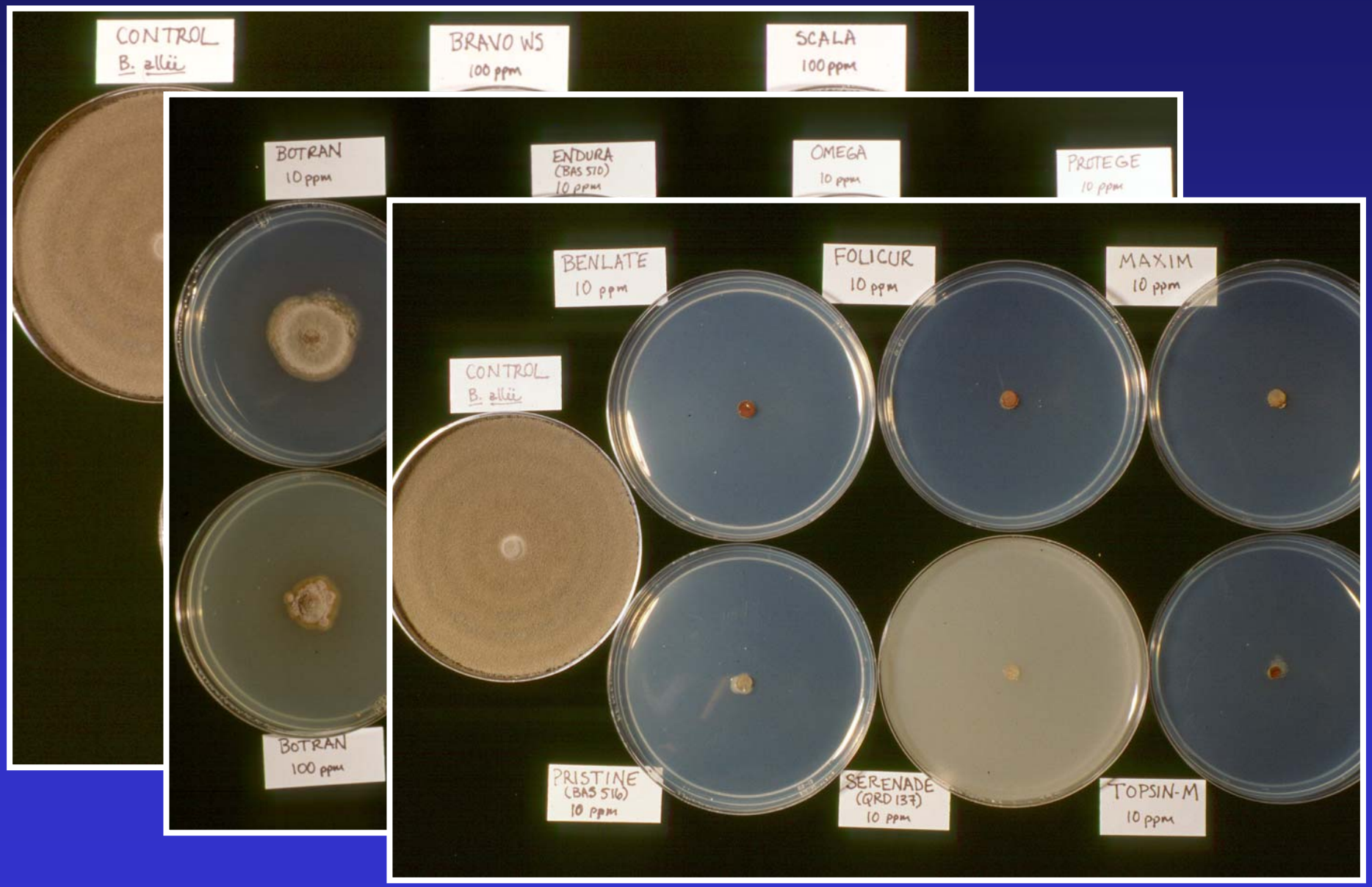


In vitro efficacy of fungicides against *Botrytis aclada*, causal agent of neck rot/scape blight of onions

6 days after plating on fungicide-amended agar



In vitro efficacy of fungicides against *Botrytis aclada* (7 days after plating on fungicide-amended agar)



Methods of seed treatment

- physical
- chemical
- biological

Physical seed treatments

- hot water
  - kill pathogens, not damage seed
  - *Phoma lingam* and *Xanthomonas campestris* pv. *campestris* on cabbage seed exposed to hot water at 50C for 30 minutes
- hot dry air
- aerated steam
- microwaves
- others, e.g., cathode rays, ultrasound

Chemical seed treatments

- chlorine = surface disinfestation
  e.g., *Xanthomonas campestris* pv. *carotae* on carrot seed
- fungicides – various products, but few qualify for organic production
- insecticide seed treatments for vector control (e.g., Gaucho), but few organic

Biological seed treatments

- problems with consistency, few available
- e.g. - *Bacillus subtilis* = Kodiak, HiStick N/T
  - *Burkholderia cepacia* = Deny

Efficacy of treatment with chlorine on eradication of seedborne inoculum of spinach leaf spot fungi

% NaOCl	Duration in NaOCl (minutes)	*Stemphylium* (% of seed infected/infested)	*Cladosporium* (% of seed infected/infested)
1.2%	0.0	54.75	55.00
	10.0	23.25	0.50
	20.0	16.75	1.00
	30.0	19.00	0.25
	40.0	18.25	0.25

Disease management during harvest, storage & conditioning of seed

- adjustment & manipulation of equipment to remove pathogen structures from seed lots (sclerotia, teliospores, etc.)

- controlled storage conditions to avoid development of storage molds

Disease management practices in production crops

- cultural practices to minimize impact of seed- or soilborne pathogens
- seed treatments to minimize transmission of pathogens
- test seed to ensure infection levels lower than inoculum threshold that can cause disease

Criteria for development/use of inoculum thresholds for seedborne pathogens

- suitable seed health assay
- incidence of infection on seeds correlated with plant infection
- inoculum thresholds established by appropriate statistical analysis, e.g.:
  - *X. campestris* pv. *campestris* of crucifers
  - *X. campestris* pv. *carotae* on carrots in CA
  - *lettuce mosaic virus*

Methods for seed health testing

- field inspections
- direct visual examination
- incubation
- grow-out
- indicator tests
- serological
- DNA hybridization

Reasons for seed health testing

- determine whether infection is below threshold
- for quarantine or phytosanitary certification
- to determine plant stand/health

Small-seeded vegetable seed crops grown in semi-arid regions of the PNW

Umbelliferous seed crops

carrot, coriander, dill, parsley, parsnip, …

Cruciferous seed cops

radish, daikon, turnip, kale, collard, kohlrabi, Chinese kale, Chinese mustard, …

Allium seed crops

onion, leek, chives, …

Others

Diseases of small-seeded vegetable seed crops

Umbelliferous seed crops

- bacterial blights
- *Alternaria* diseases: leaf blight, black rot
- powdery mildew
- phytoplasmas: aster yellows, BLTVA
- viruses: motley dwarf, BCTV, AMV, …
- root knot nematode
- cavity spot, bacterial soft rot

Bacterial leaf blight

Xanthomonas campestris pv. *carotae*

Bacterial blight
Xanthomonas campestris pv. *carotae*

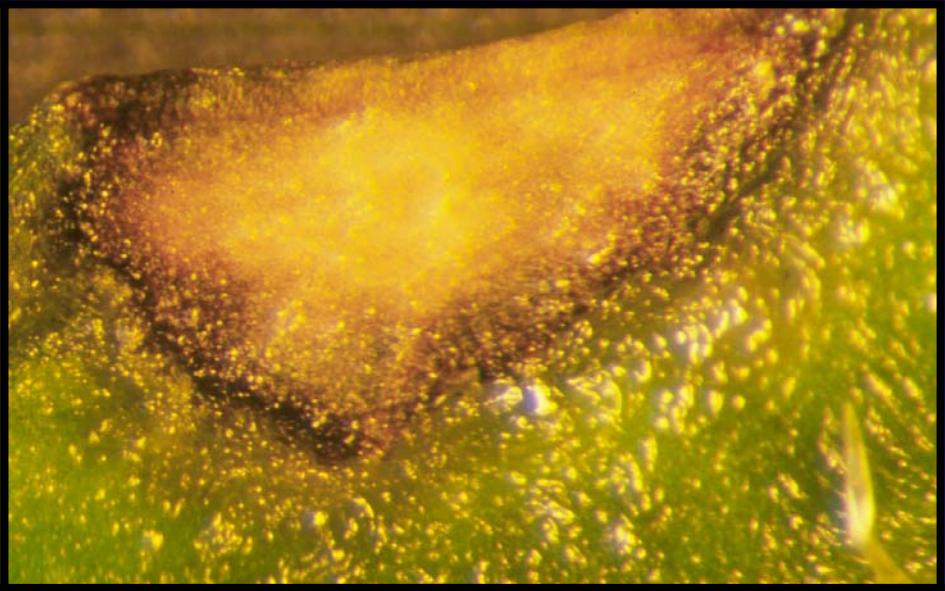
Alternaria leaf blight
Alternaria dauci

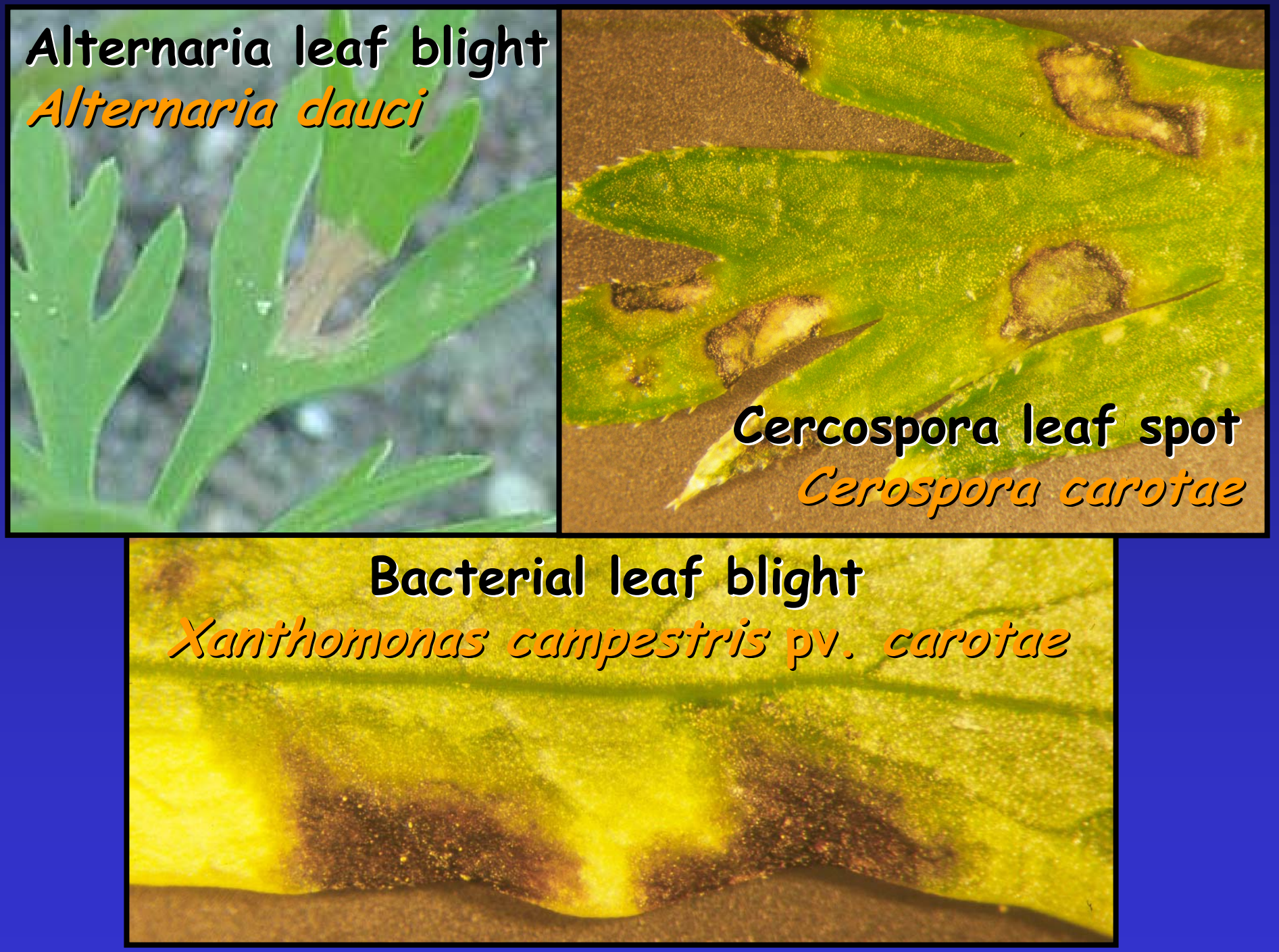
Howard et al. (1994)

carrot umbel infection by *Alternaria dauci*

Cercospora leaf spot

Cercospora carotae




Alternaria leaf blight
Alternaria dauci
Cercospora leaf spot
Cerospora carotae
Bacterial leaf blight
Xanthomonas campestris pv. carotae

Black rot
Alternaria radicina


Snowdon (1992)

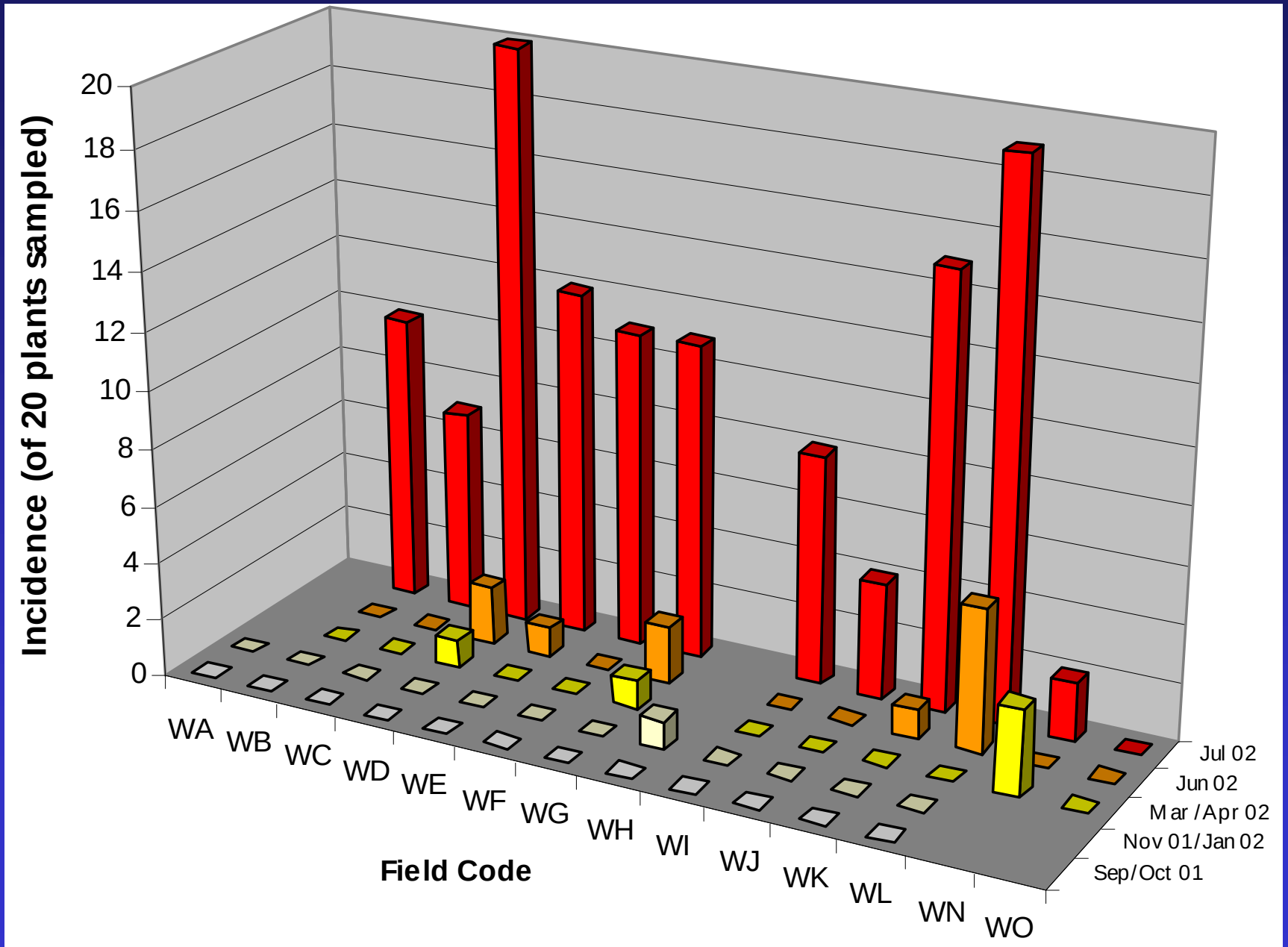

Snowdon (1992)


Howard et al. (1994)

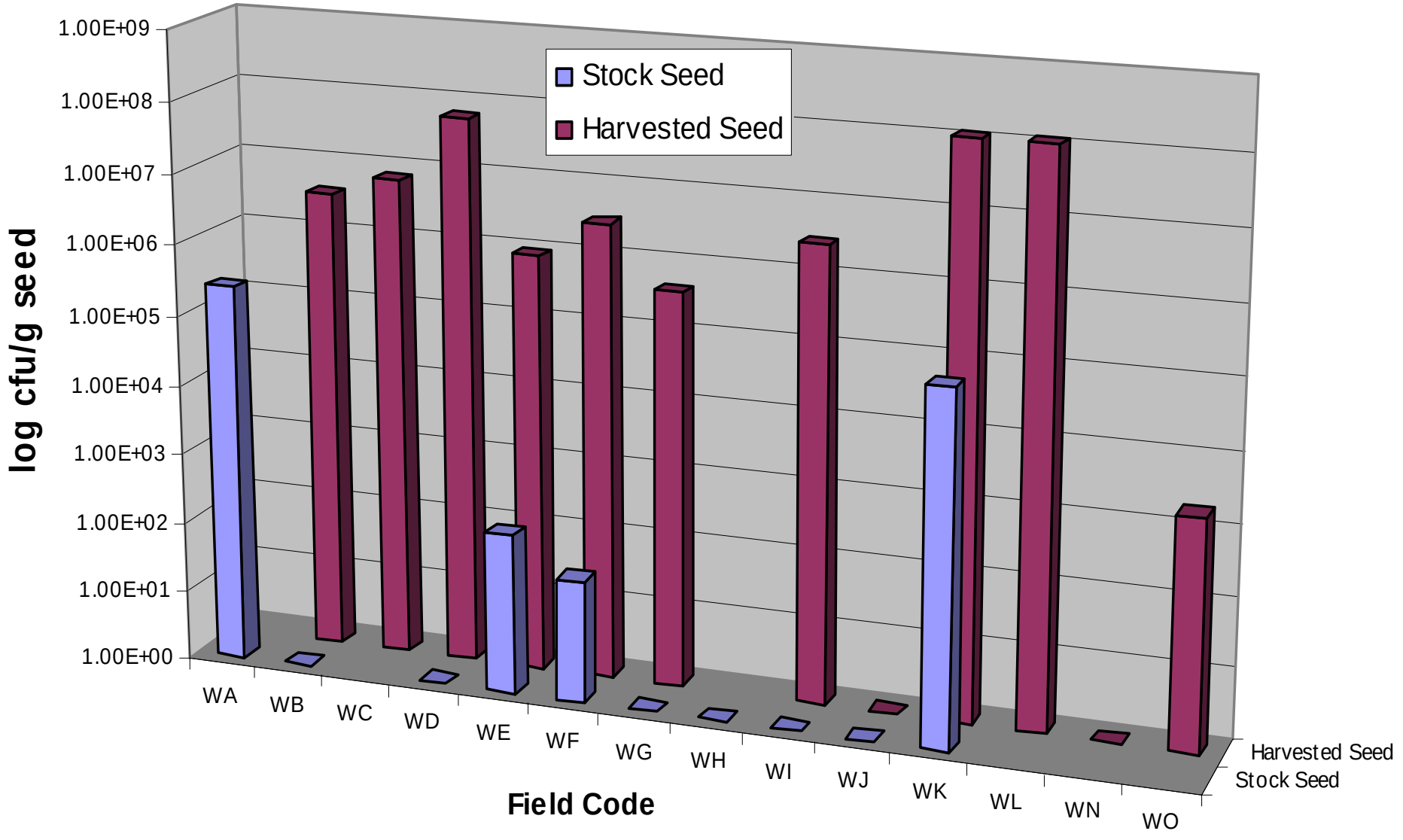
Host range

- *Xanthomonas campestris* pv. *carotae*
  carrot
- *Alternaria dauci*
  carrot, parsley, Umbelliferous weeds
- *Alternaria radicina*
  carrot, celery, parsley, parsnip, dill
- *Cercospora carotae*
  carrot, other *Daucus* species

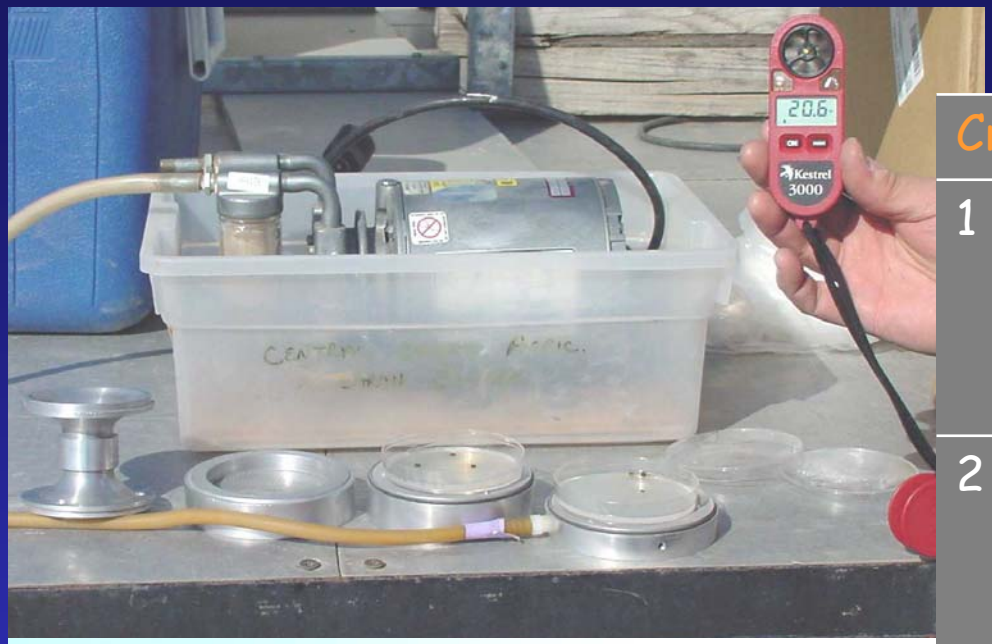
Incidence of plants on which *X. campestris* pv. *carotae* was detected in 14 carrot seed crops: WA, 2001/02



Population of *X. campestris* pv. *carotae* detected on stock seed & harvested seed of carrot seed crops: WA, 2001/02



Sampling debris/dust during threshing of seed crops



Crop	Distance	# samples	CFU/ft^3
1	100′	10	13.30
	150′	7	33.70
	250′	3	1.80
2	25′	4	15.00
	100′	12	10.40
	150′	1	0.00
	200′	8	1.00
	300′	1	0.00
	800	3	0.00
3	900′	8	0.00
4	~ 1 mile	5	0.02

Management of bacterial blight in carrot seed crops

- pathogen-free seed or stecklings
- avoid overhead irrigation, where possible
- crop rotation
- plow or disc infested residues
- isolation from carrot root crops, seed crops
- copper applications, chlorine?, compost teas??
- hot water seed treatment @ 122°F for 30 min
- chlorine seed treatment (surface efficacy)