

**Evaluation of systemic acquired resistance
for suppression of *Xanthomonas hortorum*
pv. *carotae* in carrot seed crops**

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What is Bacterial Blight?

Xanthomonas hortorum pv *carotae*

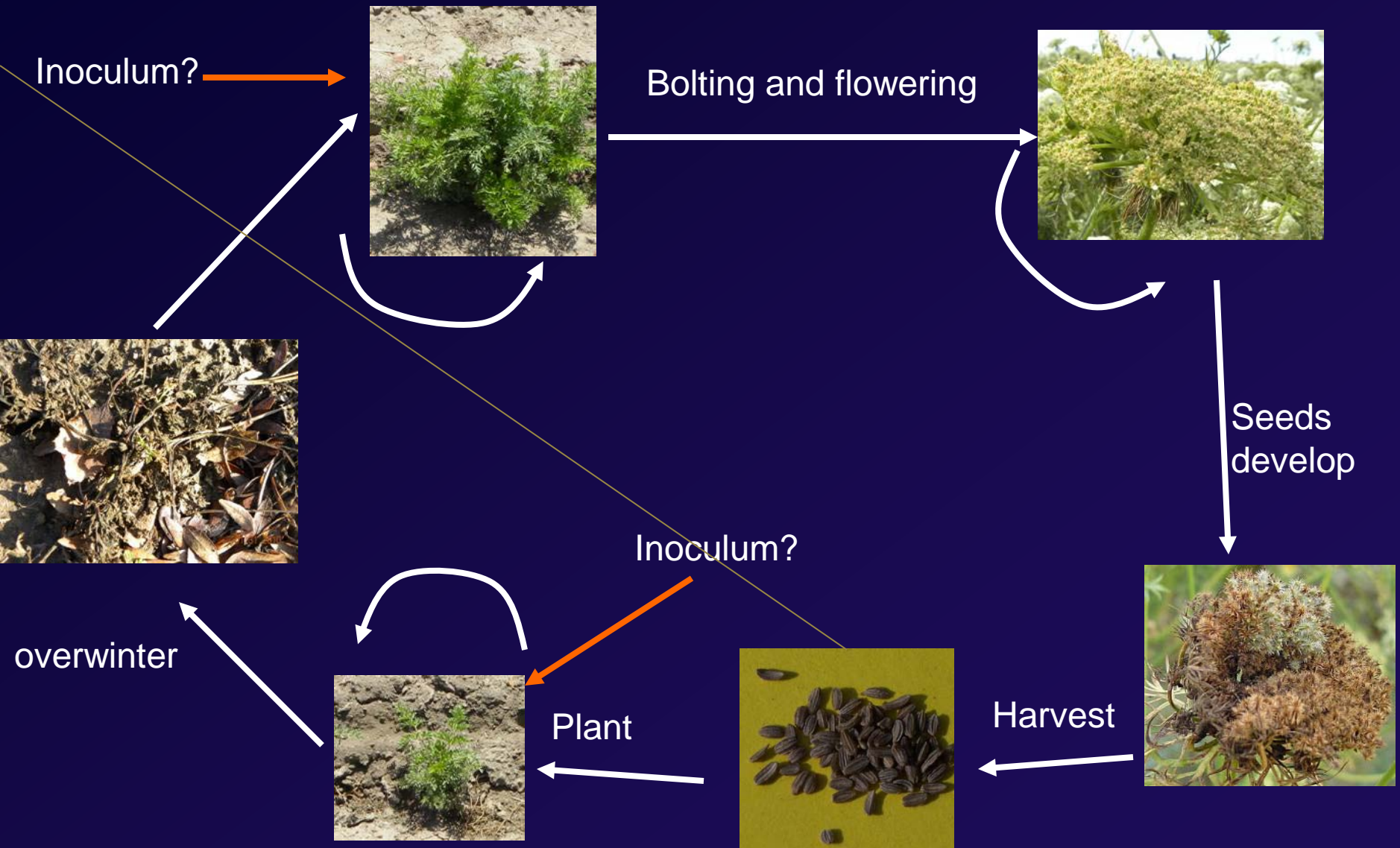


- Dark brown lesions on leaves, stems and petioles
- Blight of partial or entire umbels
- A gummy bacterial exudate may develop
- Seed borne and threshold 10^4 to 10^5 cells/g seeds

Economic Impact of Bacterial Blight

- Reduced seed yield
- Reduced seed germination rate
- Require hot water treatments
- Rejection of seed lots due to contamination

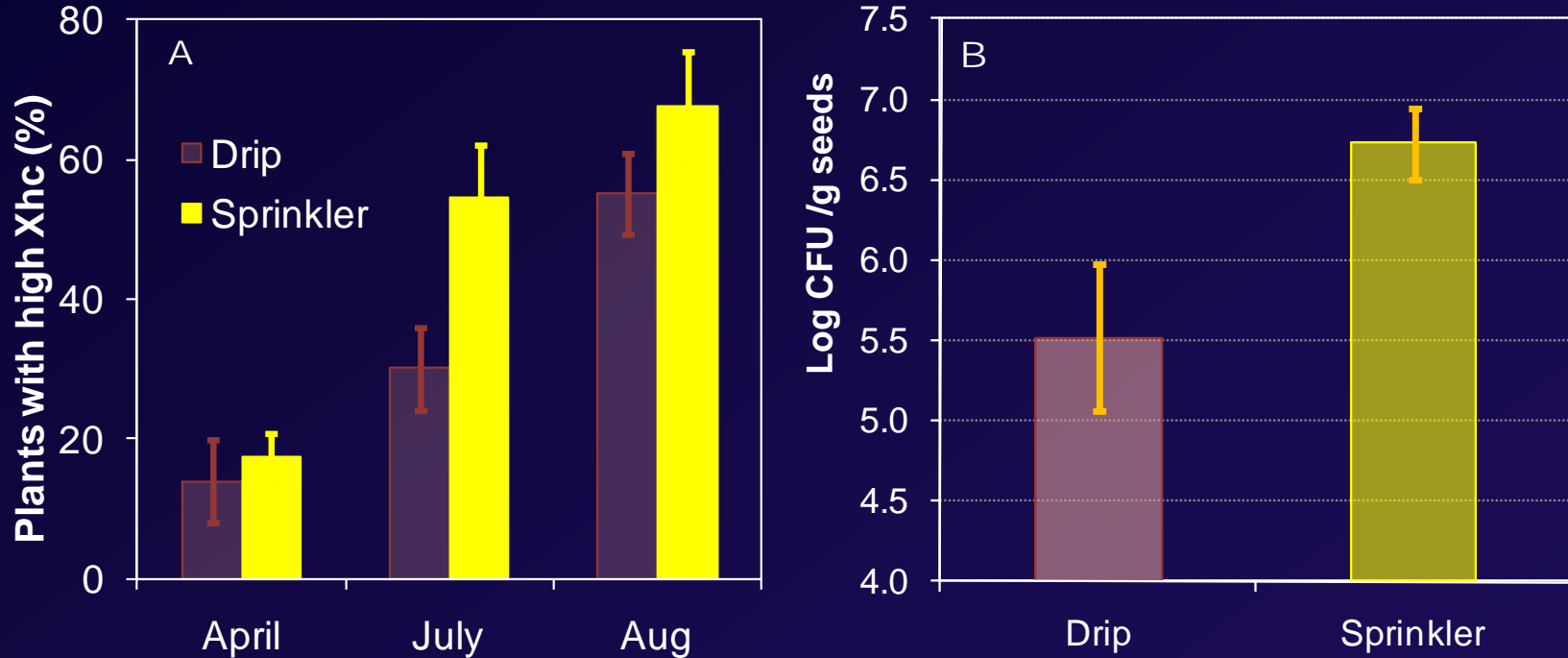
Disease Cycle of Bacterial Blight



Management of Bacterial Blight

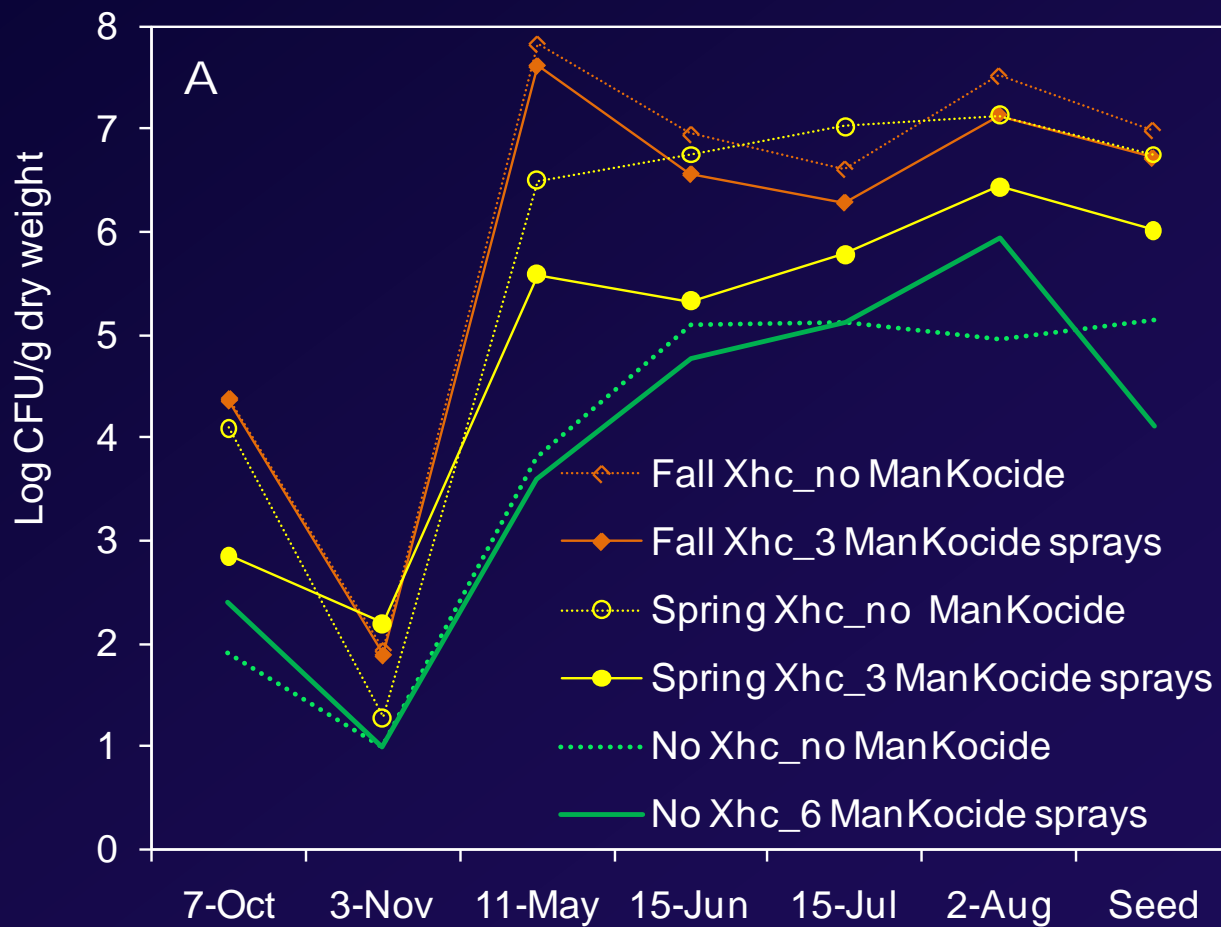
- Crop rotation
- Resistance
- Disease-free seed/stecklings
- Hot water seed treatment
- Weed control
- Management of residues
- Irrigation
- Chemical control

Effects of Irrigation



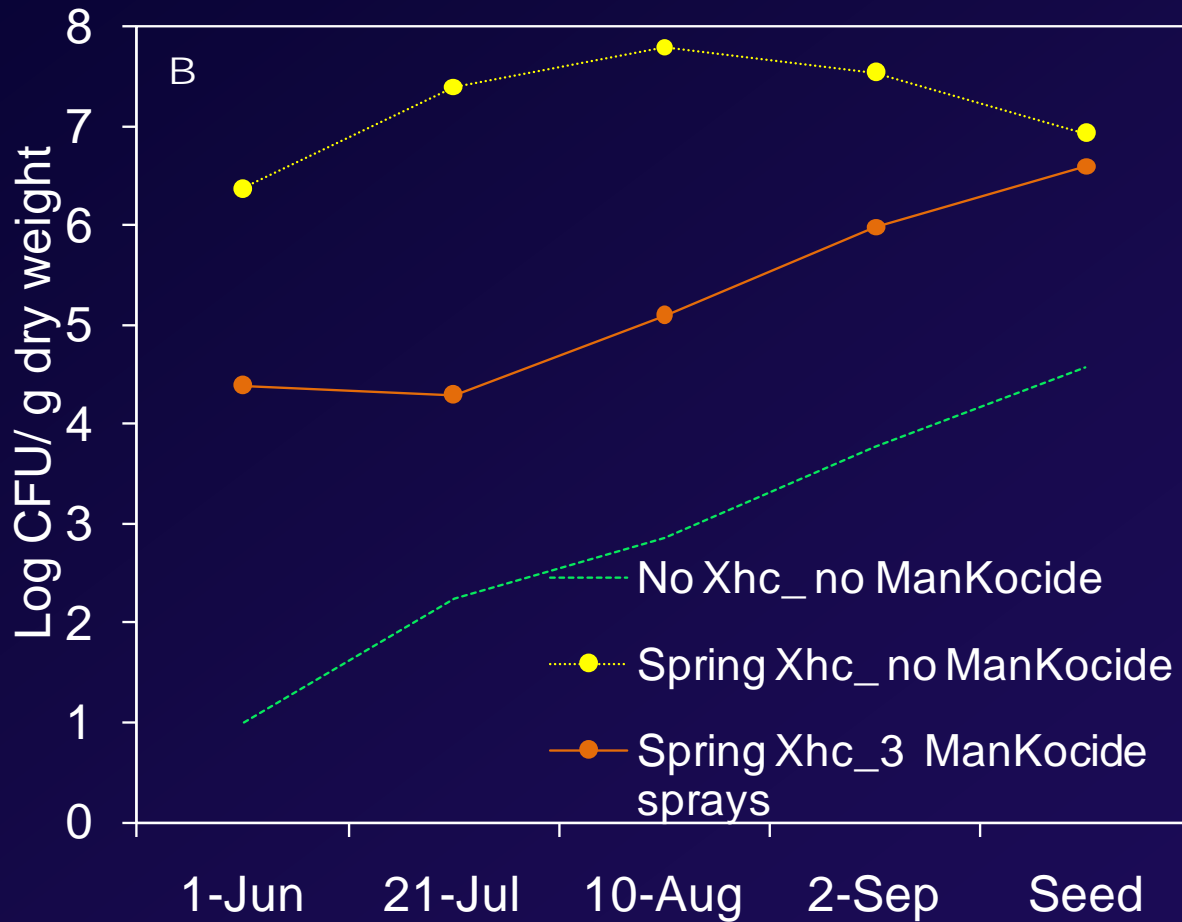
Effects of irrigation population of *X. hortorum* pv. *carotae* (Xhc) on carrot seed crop (Data from Crowe et al. COARC 2005 Annual Report pages 1-22.)

Effects of ManKocide (seed-to-seed carrot 2008-2009)



Three sprays of ManKocide were applied, including 1 pre- and 2 post- inoculation sprays. (unpublished data, Simmons et al., COARC)

Effects of ManKocide (steckling-to-seed carrot 2009)

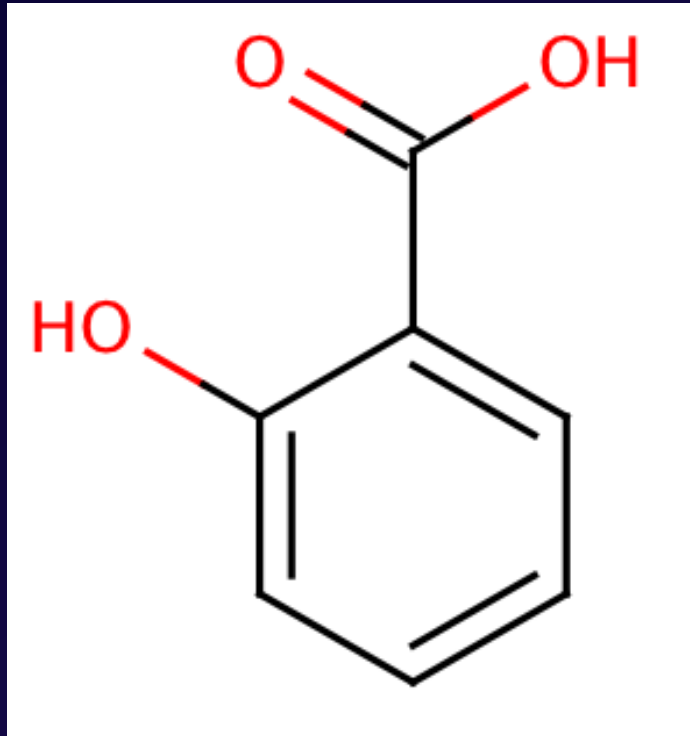


Three sprays of ManKocide were applied, including 1 pre- and 2 post- inoculation sprays. (unpublished data, Simmons et al., COARC)

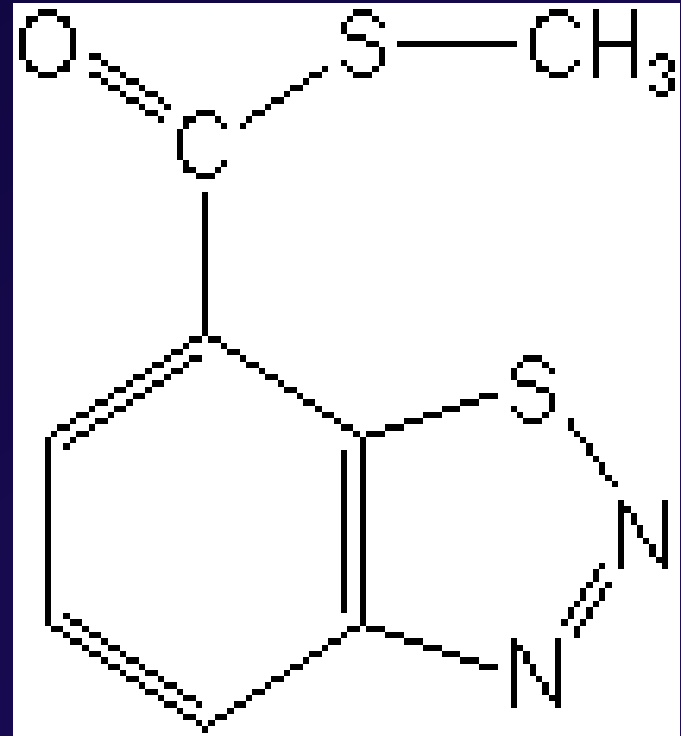
Systemic Acquired Resistance

- ▣ It can be induced by biotic/abiotic factors and provides protection to distal plant parts against a broad spectrum of pathogens
- ▣ It is characterized by increased expression of pathogenesis-related (PR) genes
- ▣ Salicylic acid, transported systemically as signal molecule.
- ▣ Acibenzolar-S-methyl (ASM), a functional homologue of salicylic acid, can be tolerated by most crop plants, and marketed with the trade names Bion®, Actigard® or Boost®

Similarity between ASM and SA

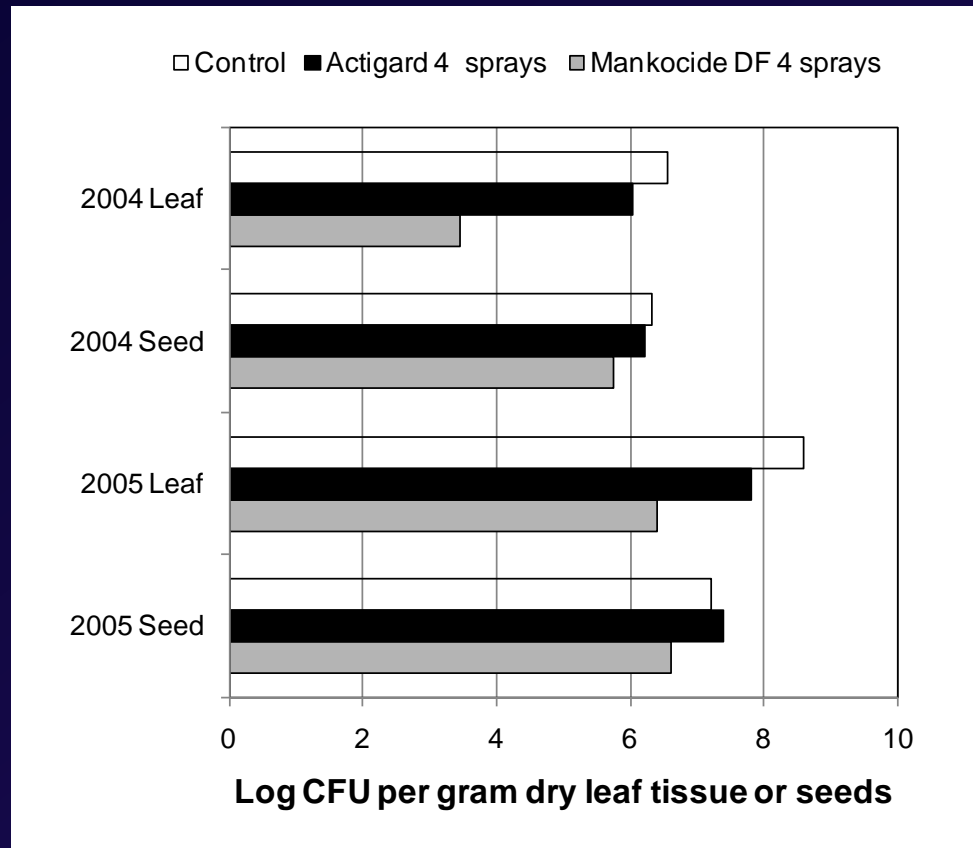


Salicylic Acid

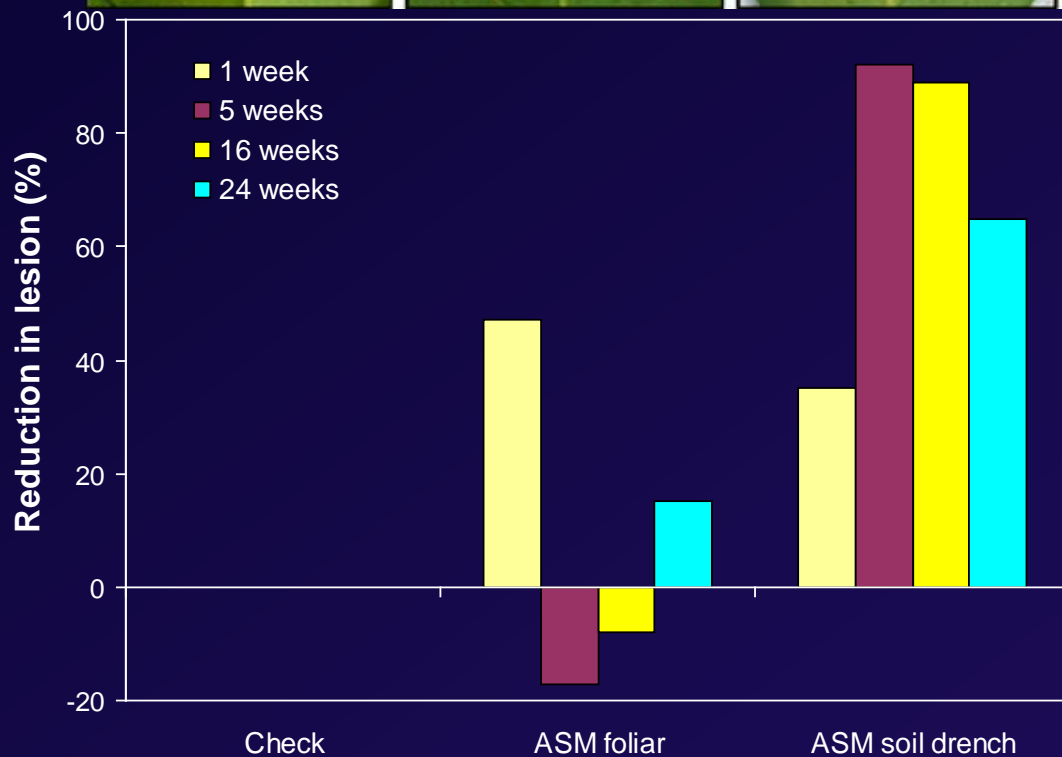
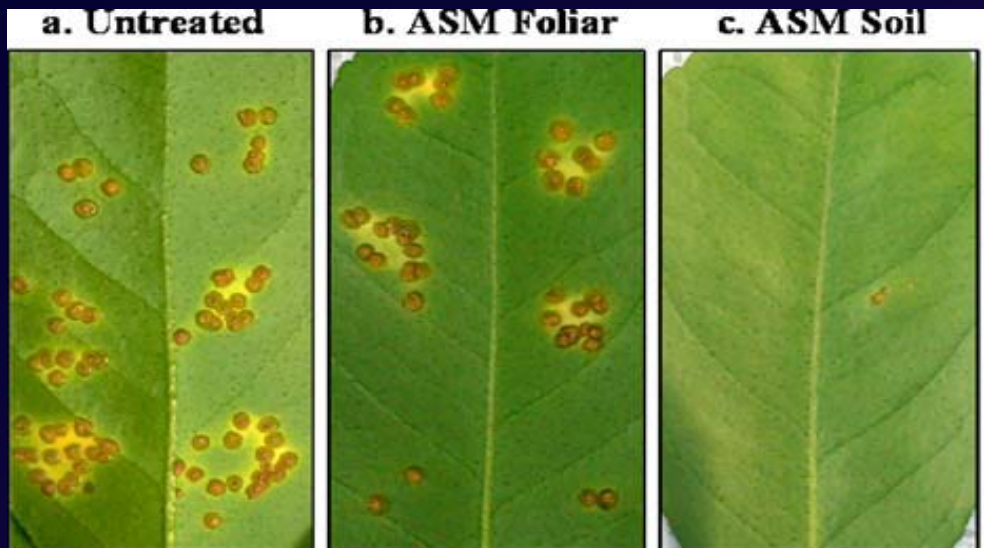


Acibenzolar-S-methyl

Foliar spray of Actigard



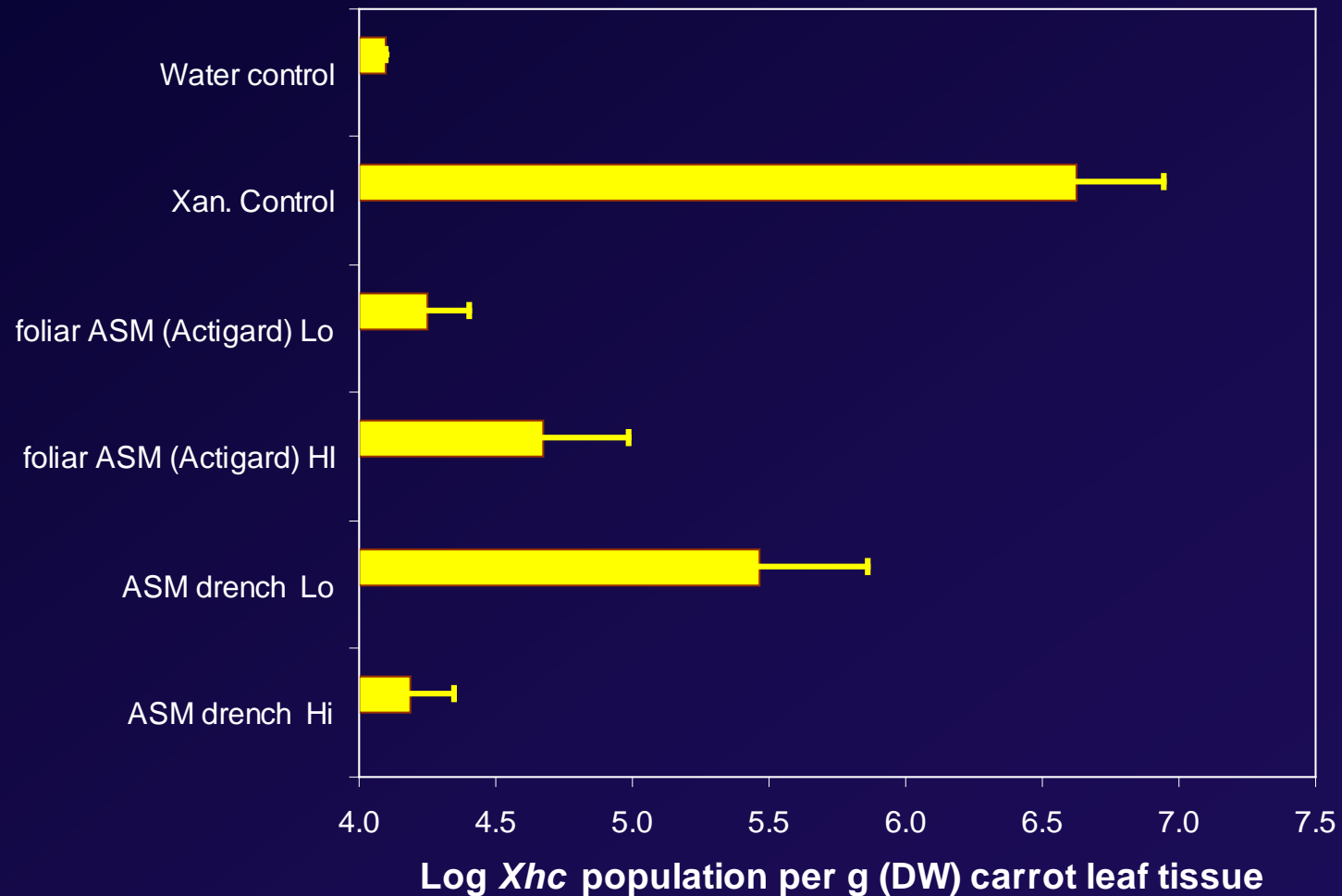
Effects of foliar sprays with Actigard and ManKocide on *X. hortorum* pv. *carotae* populations on carrot leaves and seeds. (Data from du Toit and Derie 2005 Fungicide & Nematicide Tests 60:V046 and du Toit et al. 2006 Fungicide & Nematicide Tests 61:V042.)



- Soil drench with ASM provided long term control of citrus canker
- Reduced canker lesions significantly
- Resistance induction was confirmed by gene expression

Francis, et al. 2009, Eur. J. Plant Pathology 124:283-292.

ASM Applications for Bacterial Blight of Carrot in Greenhouse



(Provided by Dr. K. B. Johnson, OSU)

Summary

- Carrot seeds from fields with drip irrigation have lower *Xhc* than those with sprinkler irrigation;
- Foliar spray of ManKocide may suppress *Xhc* population on leaves at early growth stages, but no guarantee of low *Xhc* on seeds harvest;
- Foliar spray of Actigard exhibited low efficacy against *Xhc*;
- Soil drench of Actigard provided long-term protection in other pathogen systems;
- Soil drench showed good potential in a greenhouse study of *Xhc* on carrot seedlings.

Potentials Using Actigard

- Long-term effect?
 - Up to 24 weeks on citrus and ≥ 3 weeks on carrots
- Easy to apply?
 - Via drip irrigation, which is widely used in Pacific North West carrot seed production areas
 - Targeting at whole plants including umbels and seeds
- Unknowns
 - Strength and duration of induced resistance
 - Dose for desired control of *Xhc*

2010 Field Trial at COARC

Treatments

1. No Actigard or ManKocide check;
2. Actigard through drip at 2 oz/A on 6/8, 7/7 and 7/25;
3. Actigard through drip at 4 oz/A on 6/18, 7/7 and 7/25;
4. Actigard through drip at 4 oz/A on 6/18 and 7/25;
5. Actigard through drip at 8 oz/A on 6/18 and 7/25;
6. ManKocide foliar sprays twice at 2.5 lbs/A.

Data to collect

- ▣ *Xhc* population monthly
- ▣ *Xhc* population on seeds at harvest



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Greenhouse Experiments

Treatments

- Drench with 0, 5, 10 and 15 mg Actigard/pot
- Inoculated with *Xhc* 1, 3 and 5 weeks later
- No Actigard and no inoculation check

Data to collect

- *Xhc* population on leaves 6 weeks after inoculation
- Expression of PR genes

Acknowledgment

- ▣ Research is funded by California Fresh Carrot Advisory Board and Central Oregon Seed Inc.
- ▣ Rhonda Simmons, K.B. Johnson and L.J. du Toit
- ▣ Rich Affeldt and Marvin Butler