A Review of Seaweed Extract Induced Suppression of Plant Diseases

R. E. Ross[1], S. Subramanian[2] , J. S. Sangha[2], A.T. Critchley[1] and B.Prithiviraj[2]

[1] Acadian AgriTech (a division of Acadian Seaplants Limited.), 30 Brown Avenue, Dartmouth, NS, B3B 1 X8 Canada. [2] Marine Bioproducts Research Laboratory. Department of Environmental Sciences, Science, Nova Scotia Agricultural College, Truro, NS, Canada

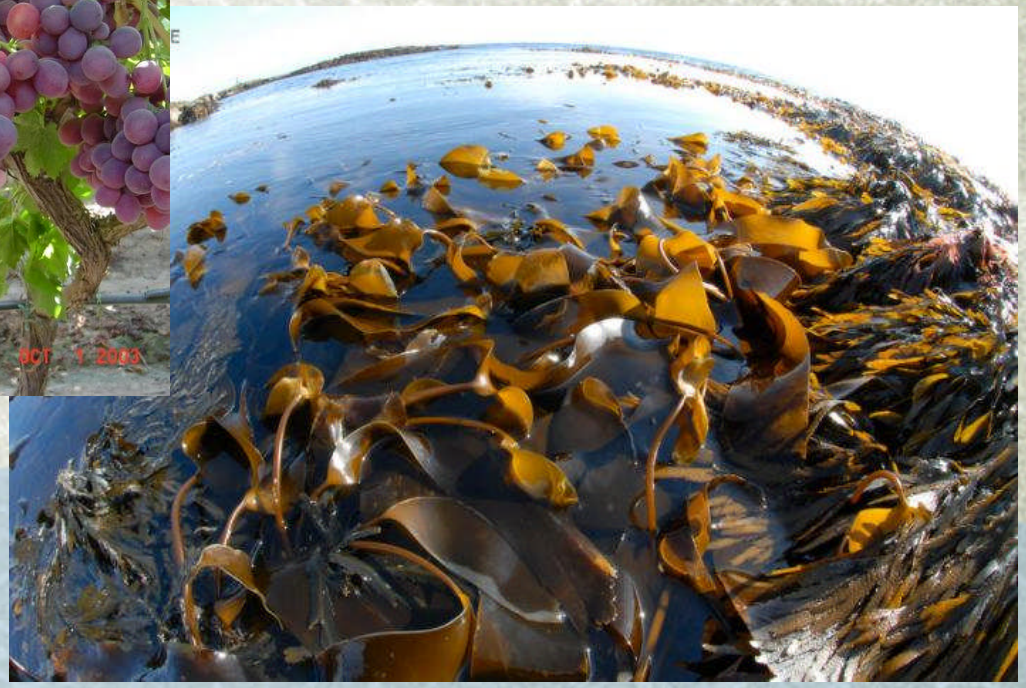
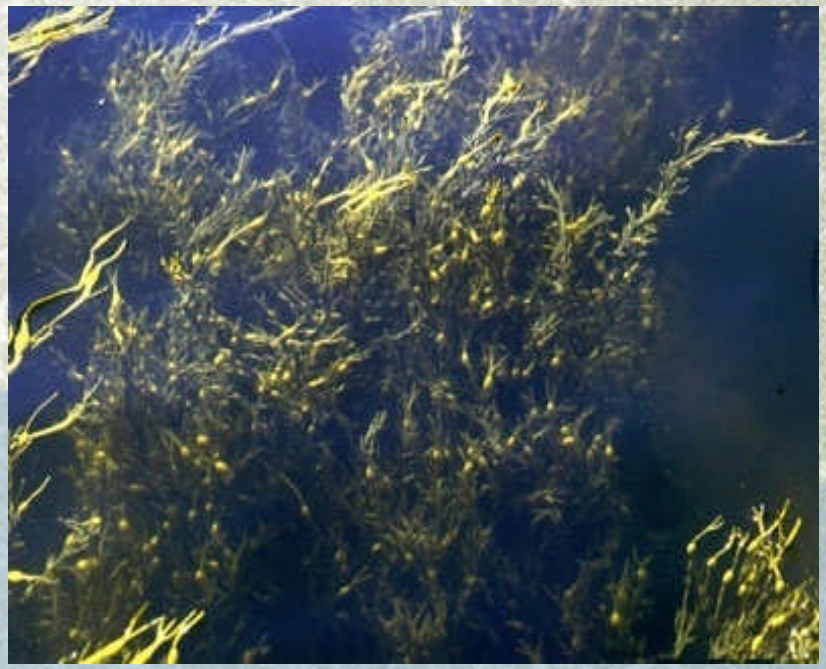


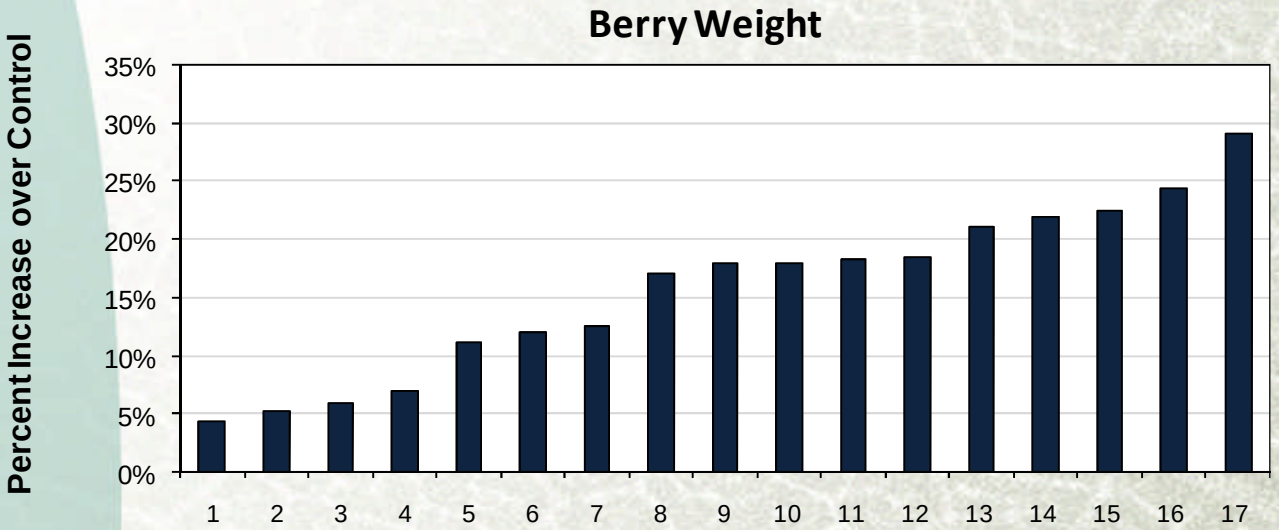
Photo courtesy ALGAEBASE and Prof MD Guiry

Using seaweed in agriculture is not a new idea.

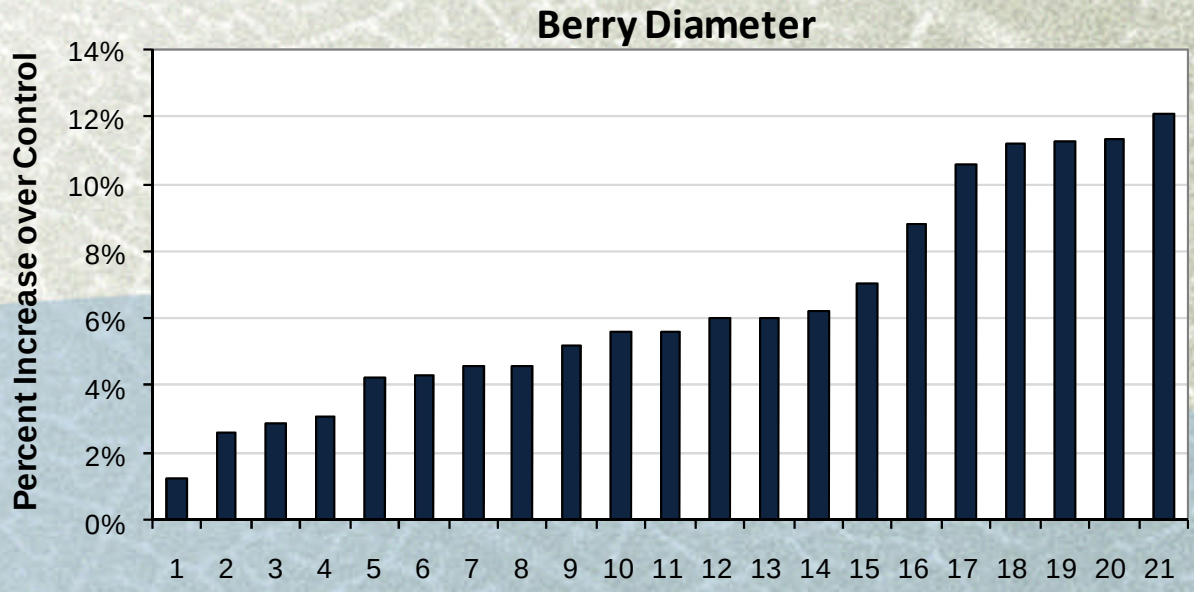
Ascophyllum nodosum



Ascophyllum nodosum on Desirable Yield



Years of field trials all show an increase in berry weight, up to 29%, with the average being 16%. In all 21 trials, where measured, berry diameter was also increased. The average increase was 6.4%, with the maximum being 12%.



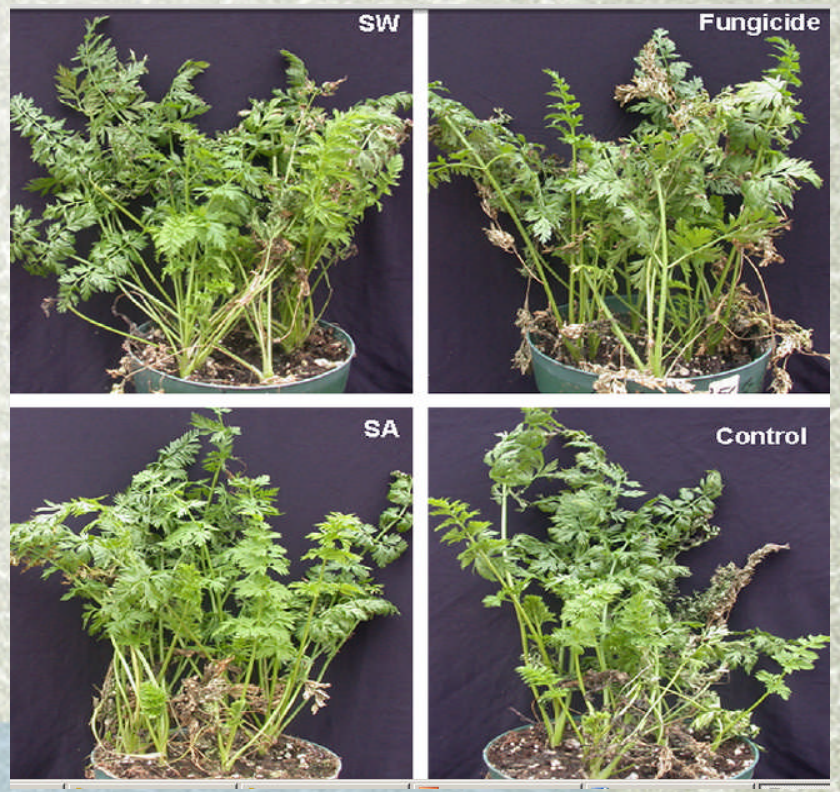
Root Diseases Caused By Fungi Suppressed by Seaweed and it's Components

- Multiple root pathogens of okra. V. Sultana et al., . 2005
- ***Macrophomina phaseolina, Rhizoctonia solani, Fusarium solani*,** and root knot nematode **(*Meloidogyne javanica*)** of greenhouse grown chili peppers. V. Sultana et al., 2008.
- ***Sclerotinia homoeocarpa*** (Dollar Spot) on bentgrass. Zhang et al., 2003.
- ***Verticillium* wilt of potatoes.** A.K. Uppal et al., 2008.
- ***Fusarium solani*** of watermelons and pumpkins. Brust et al. 2010.
- ***Sclerotinia sclerotiorum*** of *Arabidopsis thaliana*. J. Sangha et al., 2010.

Photos courtesy APS Press

Foliar Diseases Caused By Fungi Suppressed By *A. nodosum* Extract

- *A. nodosum* seaweed extract suppressed both ***Alternaria*** and ***Botrytis*** of carrots in trials conducted in the greenhouse.
- *A. nodosum* extract suppressed ***Botrytis cinerea***, ***Fusarium oxysporum***, and ***Didymella applanata*** of cucumbers
- In addition, the treated plants showed enhanced activities of various defense related enzymes and altered transcript levels of various defense genes.
- Cucumber plants treated with seaweed extract also accumulated higher level of phenolics compared to the water controls.



Jayaraj, *et al*., 2008

Diseases Caused By Oomycete Fungi Suppressed by Seaweed and it's Components

- ***Pythium ultimum*** in cabbage seedlings G. R. Dixon and U. F. Walsh. 2002.
- ***Phytophthora cactorum*** of strawberries**.** W. S. Washington et al., . *1999.*
- ***Phytophthora infestans*** on tomato**.** I. Portillo et al., 2007.
- ***Phytophthora capsici*** of peppers. along with a strong increase in the activity of soluble peroxidases and in the concentration of the phytoalexin capsidiol in peppers indicating an elicited defense response Lizzy et al., 1998.
- ***Plasmopara viticola*** in grapes. Lizzy et al., 1998.
- ***Phytophthora parasitica*** of tobacco. Mercier et al., 2001.

Photos courtesy APS Press

Bacterial Diseases Suppressed by Seaweed and It's Components

- ***Erwinia amylovora*** of Granny Smith apples. B.A. Holtz et al., 2008
- ***Xanthomonas campestris*** of cotton. B. Vinay et al., 2007
- ***Xanthomonas campestris*** (Bacterial Spot) of tomatoes. C.S. Vavrina et al., 2004.
- ***Pseudomonas syringae*** of *Arabidopsis thaliana.* S. Subramanian et al., 2009

Photos courtesy APS Press

Changes to the soil microbial community

- Application of seaweed extract PRIOR to compost being infested with the pathogen reduced damping off in cabbage caused by *Pythium ultimum*.
- Application of the seaweed extract AFTER compost is infested with the pathogen was not effective.
- Postulated that the seaweed extract stimulated beneficial microbial antagonists. Dixon and Walsh: 2002

Photos courtesy Visuals Unlimited

Elicitation of Plant's Defenses

Reports of disease suppression most often hypothesize that plant responses are elicited.

- –Polysaccharides (KloareQuatrano 1988).
- –Proteins
- –Lipids
- –Cell Wall Debris
- –Carrageenans (Mercier et al., 2001)
- –Laminaran, a linear b-(1,3)-glucan, and sulfated fucans (Kobayashi et al., 1993)
- –Betaines (Blunden and Tyihak, 2009)

An extract of the marine brown macroalga, *Ascophyllum nodosum*, induces jasmonic acid dependent systemic resistance in *Arabidopsis thaliana* against *Pseudomonas syringae* pv. *tomato* DC3000

S. Subramanian and B. Prithiviraj

Department of Plant and Animal Science, Nova Scotia Agricultural College, Truro, NS, Canada

Signaling Networks in Disease Resistance

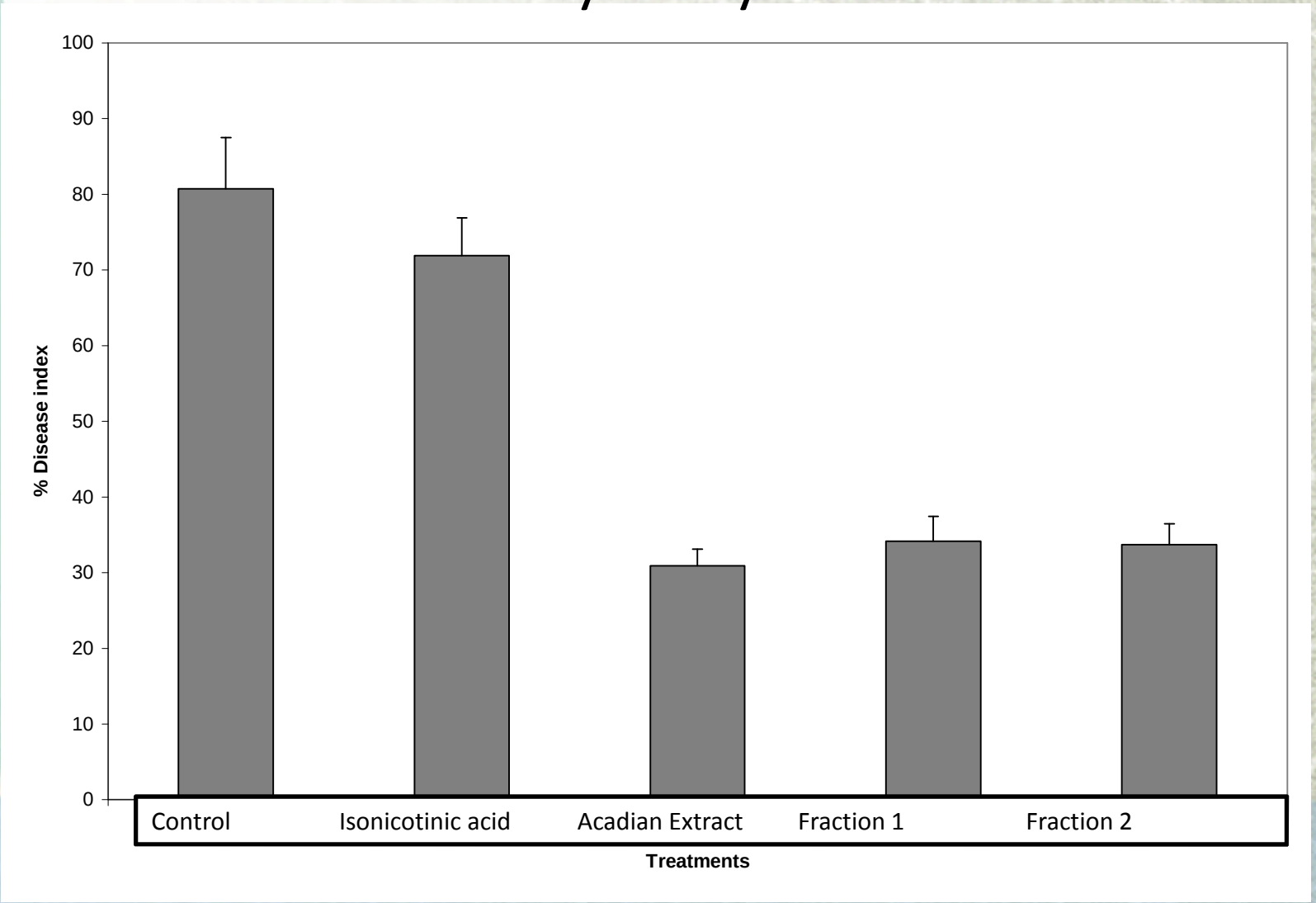
- **S**ystemic **A**cquired **R**esistance = salicylic acid pathway
- **I**nduced **S**ystemic **R**esistance = jasmonic acid pathway

NahG and *jar1* Transgenic *Arabidopsis*

- NahG is a transgenic line that will not accumulate salicylic acid
- *jar1* mutant is not responsive to jasmonic acid as a signal molecule.

NahG Salicylic Acid Mutants

Pseudomonas Severity 5 Days After Inoculation



0 = no infection, 1 = 25%, 2 = 50%, 3 = 75% and 4 = 100%

Disease Intensity = {Sum of ratings (0 -4)/Maximum possible score × Total number of leaves examined}100. Singh and Prithiviraj, 1997

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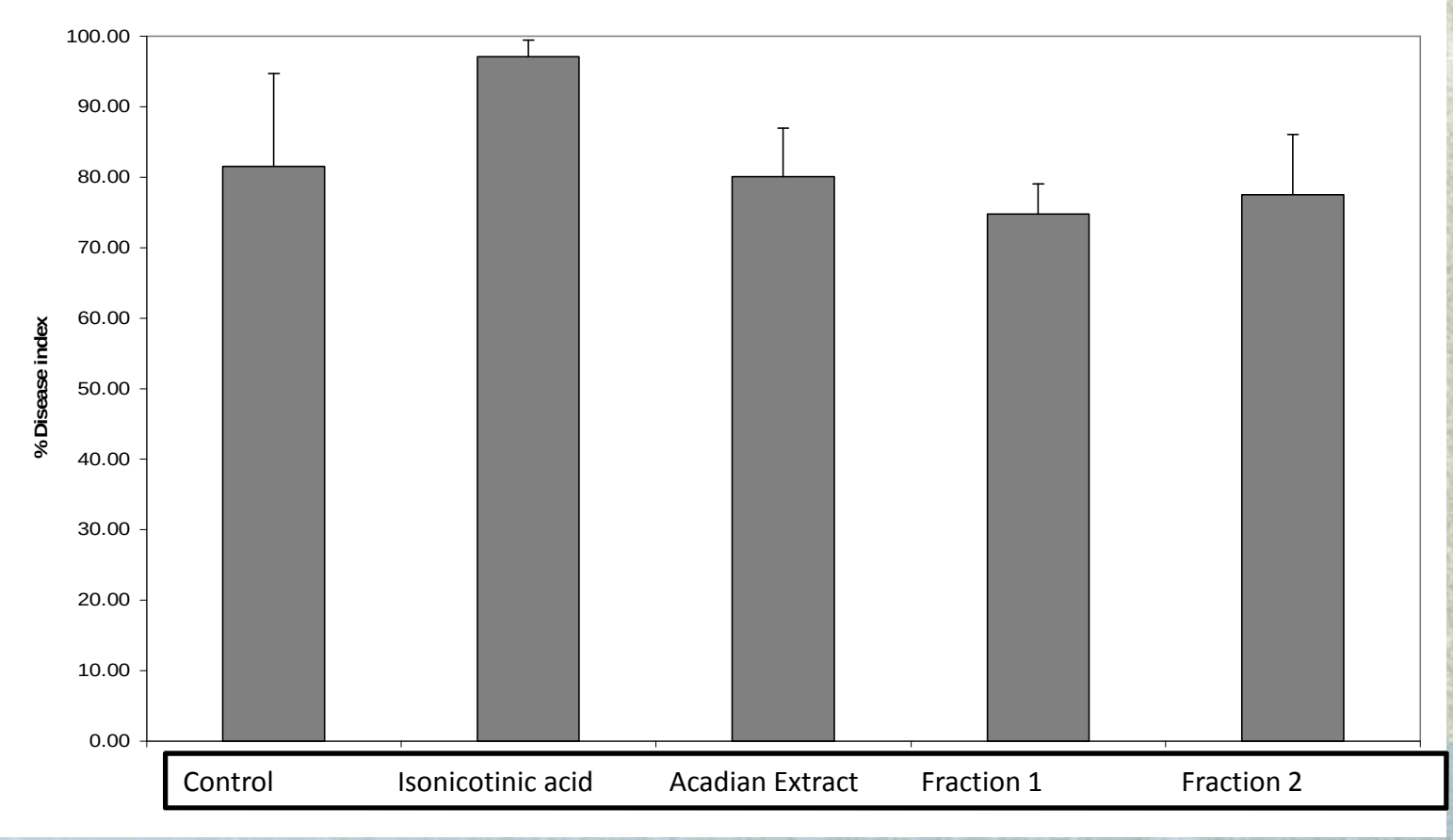

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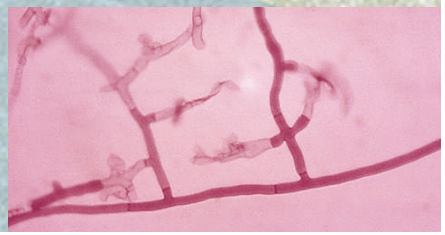
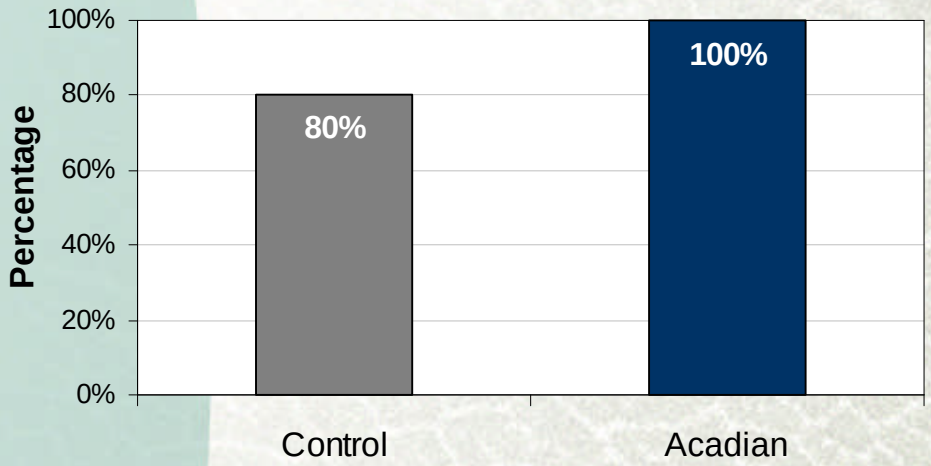
Partial List of Diseases Reported to Be Influenced By JA/Ethylene Pathway

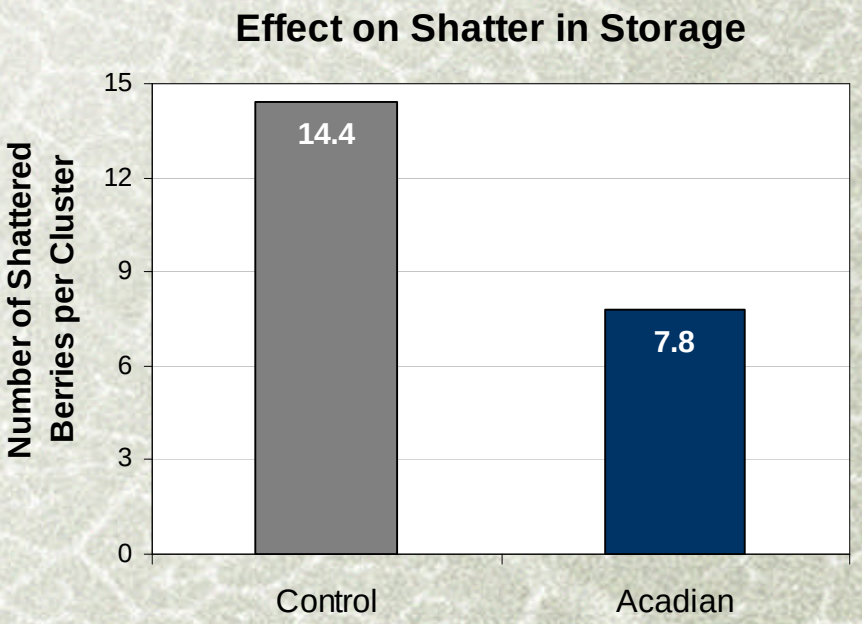
- *Alternaria brassicicola*
- *Alternaria radicina*
- *Botrytis cinerea*
- *Cercosporidium personatum*
- *Erwinia carotovora*
- *Erwinia amylovora*
- *Erwinia tracheiphila*
- *Fusarium oxysporum*
- *Fusarium solani*
- *Pseudomonas syringae*
- *Phytophthora infestans*
- *Pseudomonas syringae*
- *Pythium irregulare*
- *Pythium mastophorum*
- *Pythium sylvaticum*
- *Rhizoctonia solani*
- *Schlorotium rolfsii*
- *Sclerospora glaucum*
- *Thielaviopsis basicola*
- *Verticillium sp.*



Gary E. Vallad and Robert M. Goodman*; CROP SCIENCE, VOL. 44, NOVEMBER–DECEMBER 200
Induced Plant Defenses Against Pathogens and Herbivores, Biochemistry, Ecology, and Agriculture. APS Press, 20004

Effects on Storage Quality





In this trial on shelf life of Ruby Red Seedless grapes, the *Acadian* treated grapes had 100% of green stems even after 37 days of being in commercial storage. *Acadian* treated bunches also lost 46% fewer berries to shatter. This indicates improved in-storage quality possibly due to a reduction in water loss from the bunches or reduction in post harvest diseases.

Recommendations

Apply Acadian at 1 to 2 pounds per acre (1.1 to 2.2 kgs per hectare) at the following timings:

- **1st Application:** 1-4 inch shoot growth (foliar and soil)
- **2nd Application:** 10-12 inch shoot growth (foliar and soil)
- **3rd Application:** 5 days pre-bloom (foliar)

Avoid foliar pre-bloom application in varieties that are prone to under shatter. Use high rate in pre-bloom sprays on varieties that tend to over shatter.

- **4th-6th Applications:** sizing sprays (foliar)
- **7th Application:** veraison (foliar and soil)
- **Repeat:** every 2-4 weeks during summer months
- **Post harvest application:** 2-4 weeks after harvest

Thank you