Correlating reduced fungicide sensitivity in *C. beticola* with loss of disease control

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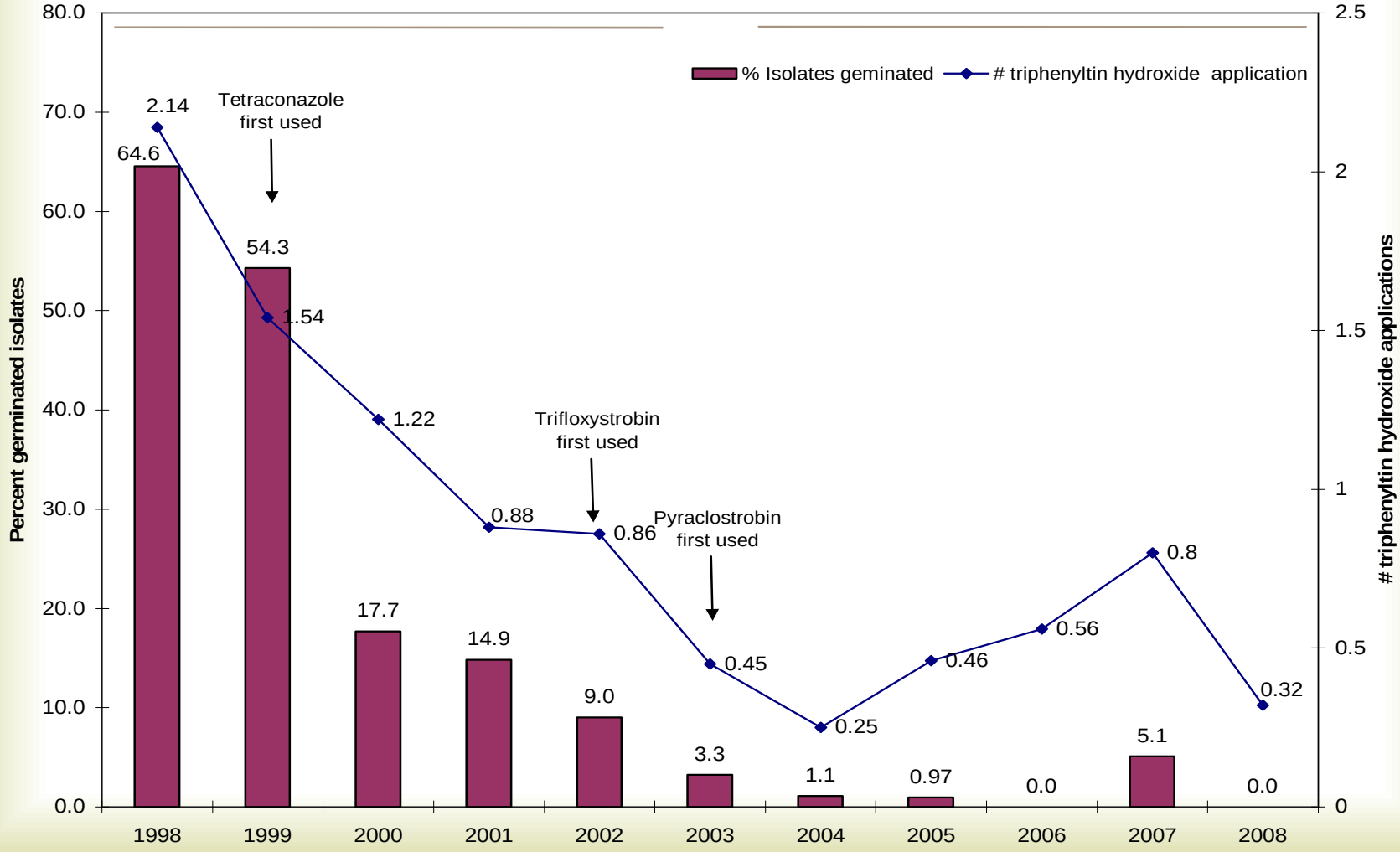
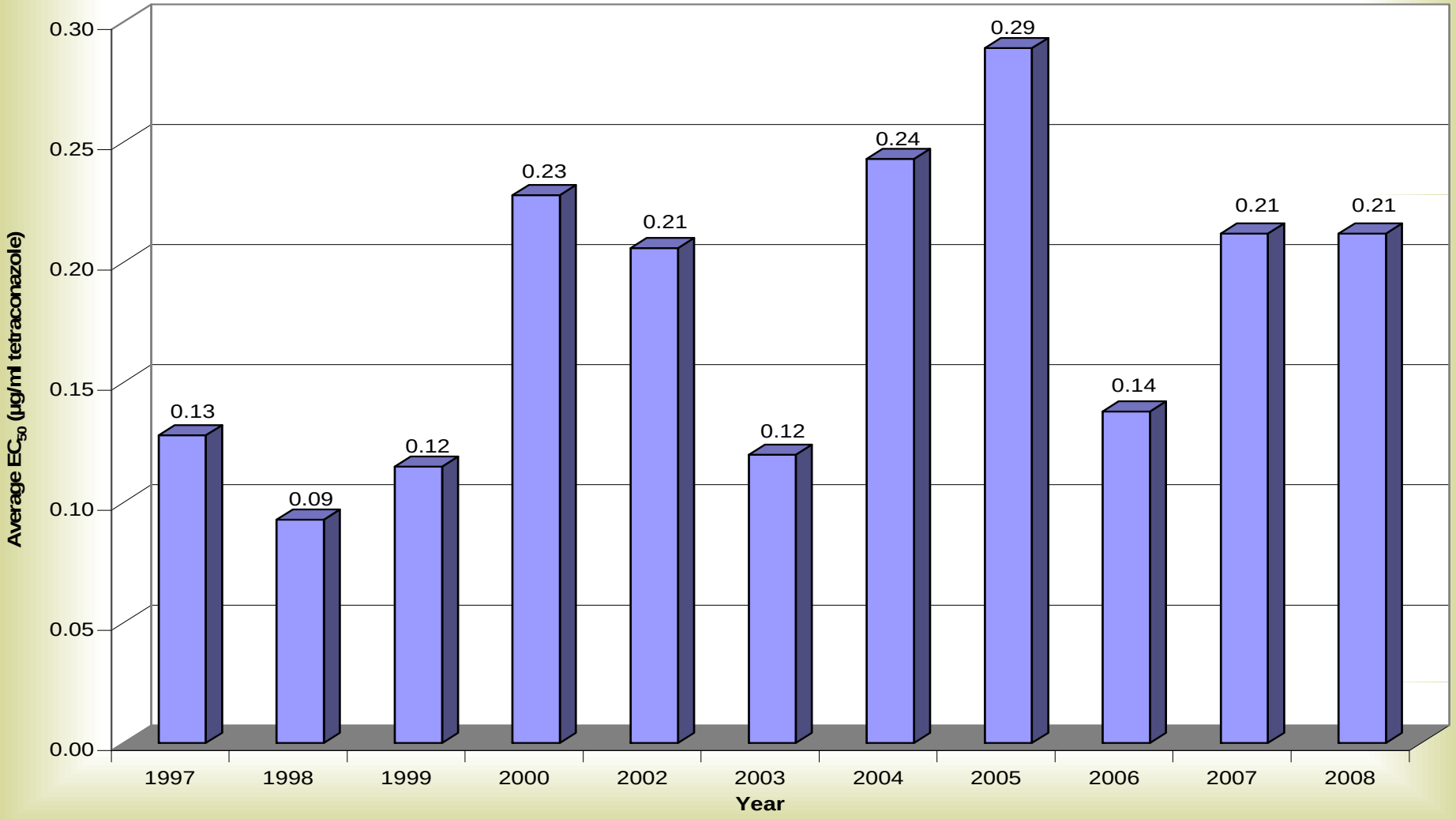
- We have been monitoring sensitivity to *C. beticola* in the RRV production area to multiple fungicides the past decade to optimize disease control
- We published a summary of our work in a Feature Article in the November issue of Plant Disease entitled "Monitoring fungicide sensitivity of *Cercospora beticola* of sugar beet for disease management decisions"
- If anyone if interested in receiving a copy of this article please let me know in person or e-mail: gary.secor@ndsu.edu
- Our results are used for fungicide recommendations by our industry

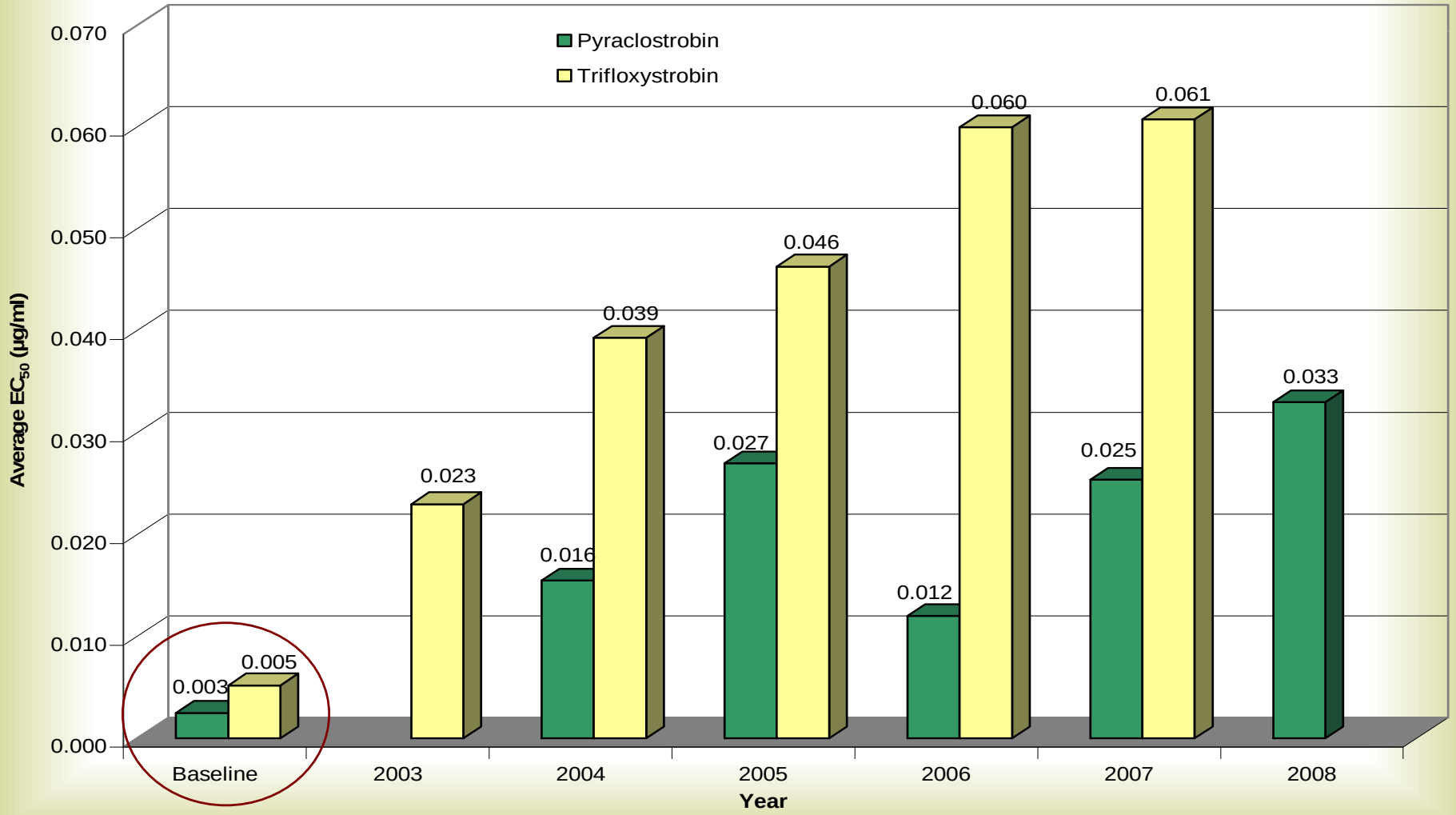
Sensitivity to triphenyltin hydroxide of *C. beticola* isolates collected in ND and MN from 1998-2008 at 1.0 µg/ml as measured by bulk spore germination of 100 isolates/field. The blue line shows the decline in the number of triphenyltin hydroxide applications during this period. The arrows show the year of first use of tetraconazole in sugar beet in 1999, trifloxystrobin in 2002 and pyraclostrobin in 2003



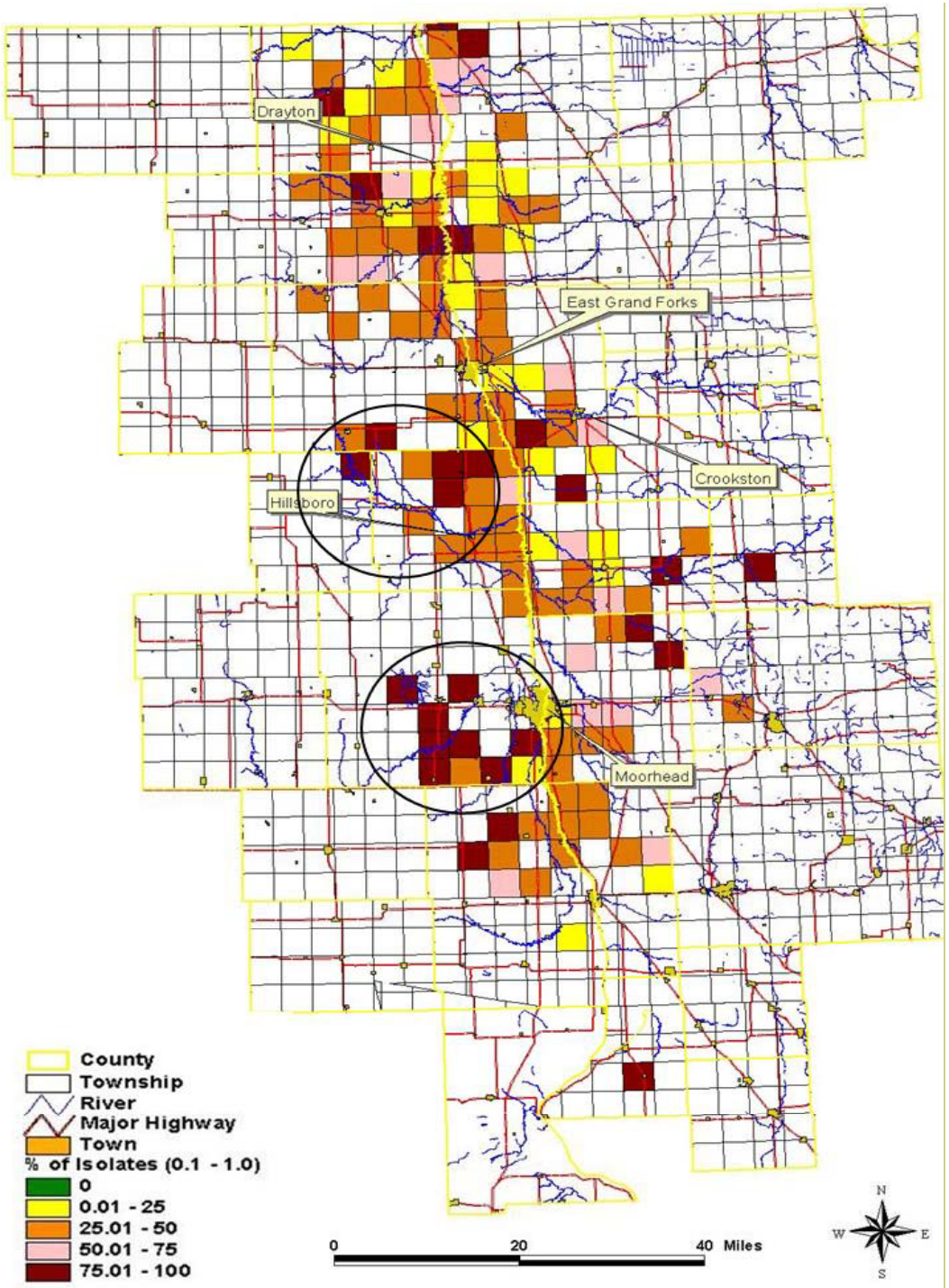
Average EC_{50} value of *Cercospora beticola* isolates collected from 1997-2008 to tetraconazole. There is a significant increase in the resistance factor as measured by the average EC50 values from 2000-2008 compared to the baseline EC50 values from 1997-1999 (p=0.05)



Average EC_{50} values to trifloxystrobin and pyraclostrobin of *C. beticola* isolates collected in MN and ND from 2003-2008. Note the circled baseline values of isolates collected prior to the use of either fungicide.



Cercospora beticola fungicide sensitivity map illustrating the range of sensitivity to tetraconazole by township in the sugar beet production area of ND and MN. Note the clustering (circled) of isolates having high EC_{50} values (0.1 – 1.0 µg/ml).



Sensitivity of *C. beticola* field isolates to fungicides in 2009 and 2010

	2009	2010
Super Tin % germinated isolates (Res)	2	1.4
Tetraconazole EC_{50} average % Isolates > 1ppm	0.250 6.6	0.256 (0.402)* 19
Inspire EC_{50} average % Isolates > 1ppm	0.096 0.5	0.174 (0.243) 8.4
Headline EC_{50} average % Isolates > 1ppm	0.022 0	0.111 (0.132) 2.3

- * 1st # = without isolates > 1
- 2nd # () = with isolates > 1

Impact of resistance

- What to all these EC_{50} values mean to the grower? Do the increased EC_{50} values mean less disease control?
- In order to answer these questions we conducted two studies:
  - Field study at Foxhome with two sources of inoculum
  - Greenhouse study

Field Study

CLS disease September 11, 2010 in identical fungicide trials at Foxhome fungicide trials inoculated with two sources of inoculum

Fungicide Plot	CLS	
Treatment	Fargo	Crookston
Untreated	10	10
Super tin	7.3	6.8
Eminent	8.3	10
Inspire	5.8	7.5
Headline	6.3	6.3
Proline	5.0	8.5

Sensitivity to triazole fungicides of *C. beticola* isolates collected from identical fungicide trials August 30, 2010 inoculated with two sources of inoculum at Foxhome

Fungicide Plot	Eminent EC_{50} values		Inspire EC_{50} values	
Treatment	Fargo	Crookston	Fargo	Crookston
Untreated	0.396	> 1	0.065	> 1
Super tin	0.300	0.505	0.060	0.067
Eminent	0.428	> 1	0.092	> 1
Inspire	0.561	> 1	0.071	0.878
Headline	0.207	> 1	0.051	0.766
Proline	0.203	> 1	0.065	> 1

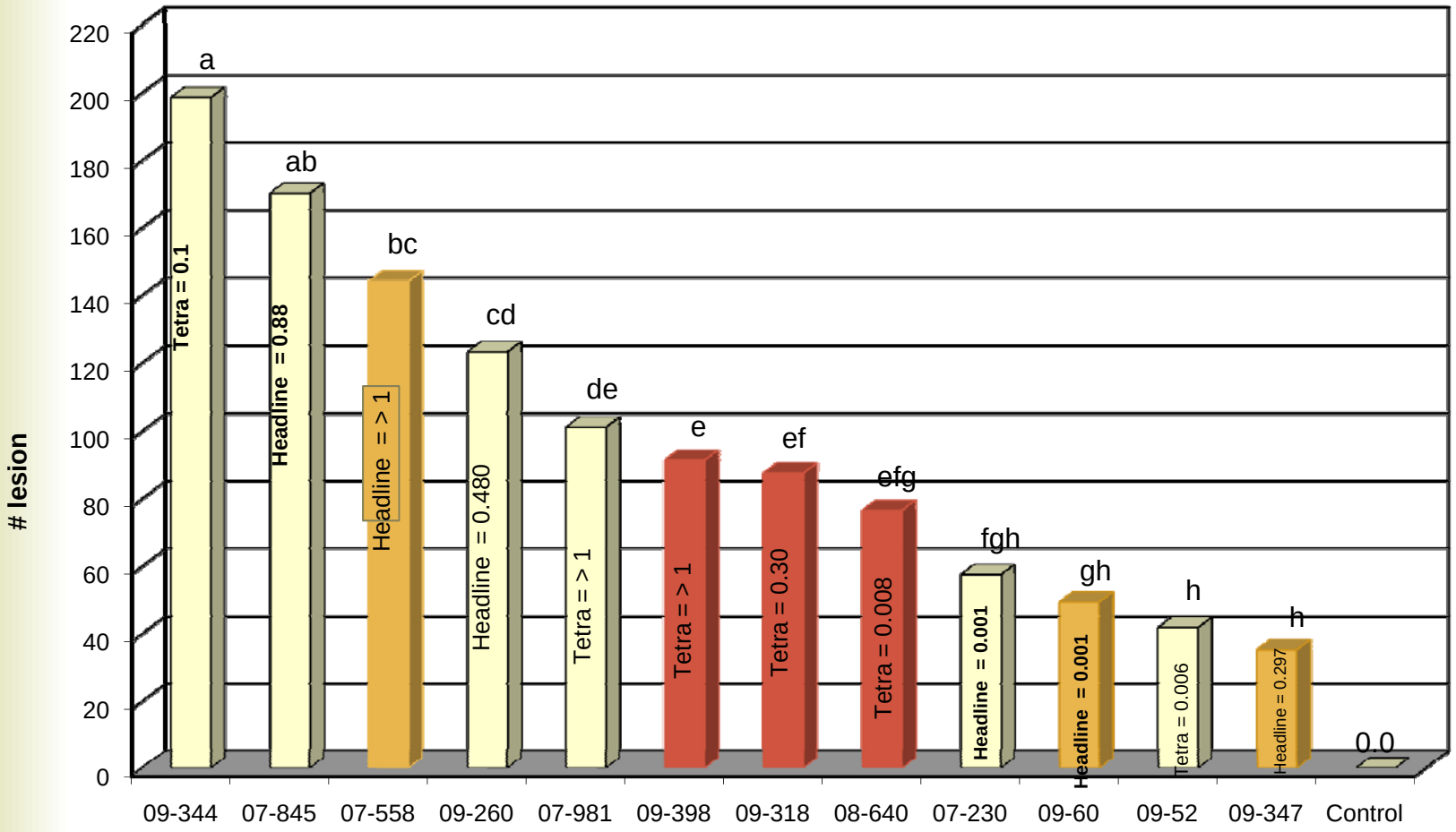
Source of inoculum

- 5 additional isolates from 6 fungicide plots inoculated with Crookston inoculum (resistant) were tested to confirm resistance to triazole fungicides
  - 100% of isolates tested from plots treated with triazole fungicides were resistant to Eminent; EC_{50} >1
  - 26.6% of the isolates were resistant to Inspire; EC_{50} = 0.647
  - 7% of the isolates were resistant to Headline with EC_{50} average = 0.163
  - Some isolates with EC_{50} > 1 to all three fungicides
  - Showed consistent reduced sensitivity to triazole fungicides

Greenhouse Study

- Isolates with three levels of sensitivity to Eminent were used in the study
  - Resistant
  - Intermediate
  - Sensitive
- Isolates used in this study were chosen for fungicide sensitivity and aggressiveness based on lesion numbers on inoculated leaves
- Plants treated with 10–fold dilutions of Eminent at concentrations from the field rate of 625 ppm (13 oz/a) to 0.000625 ppm
  - Fungicides were applied using a spray bar to simulate field application
  - Plants inoculated 4-6 hours after fungicide application

Isolates selected for GH study



- Each treatment consisted of 5 plants and three replications
- Plants were inoculated with a spore suspension of 40,000 spores/ml
- Plants were incubated in a humid chamber at 37°C under high light to allow infection
- Plants were transferred to the greenhouse and evaluated for disease after three weeks
- Four leaves from each plant were harvested individually and scored for disease
  - Numbers of lesions
  - Converted to disease scores

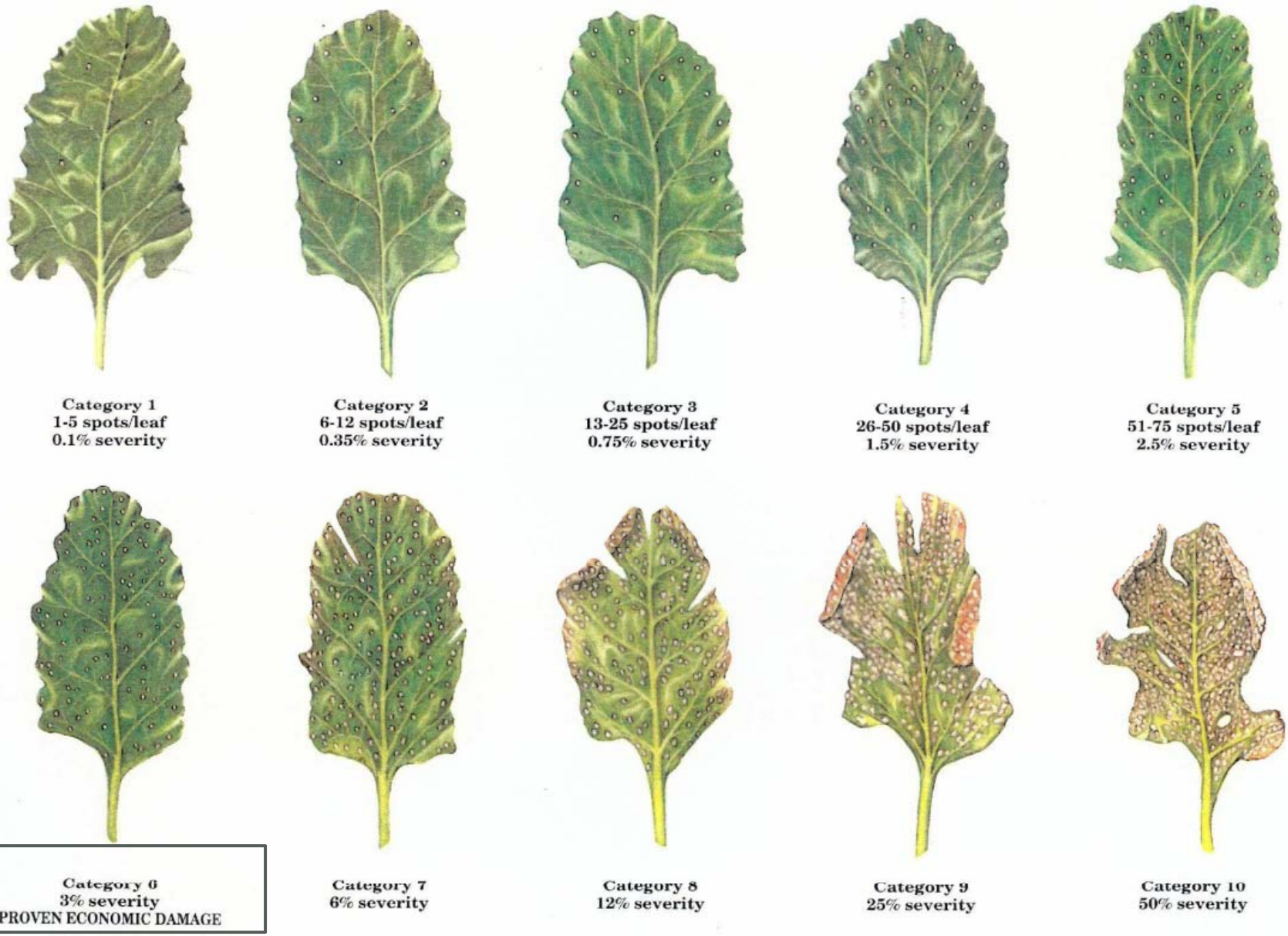
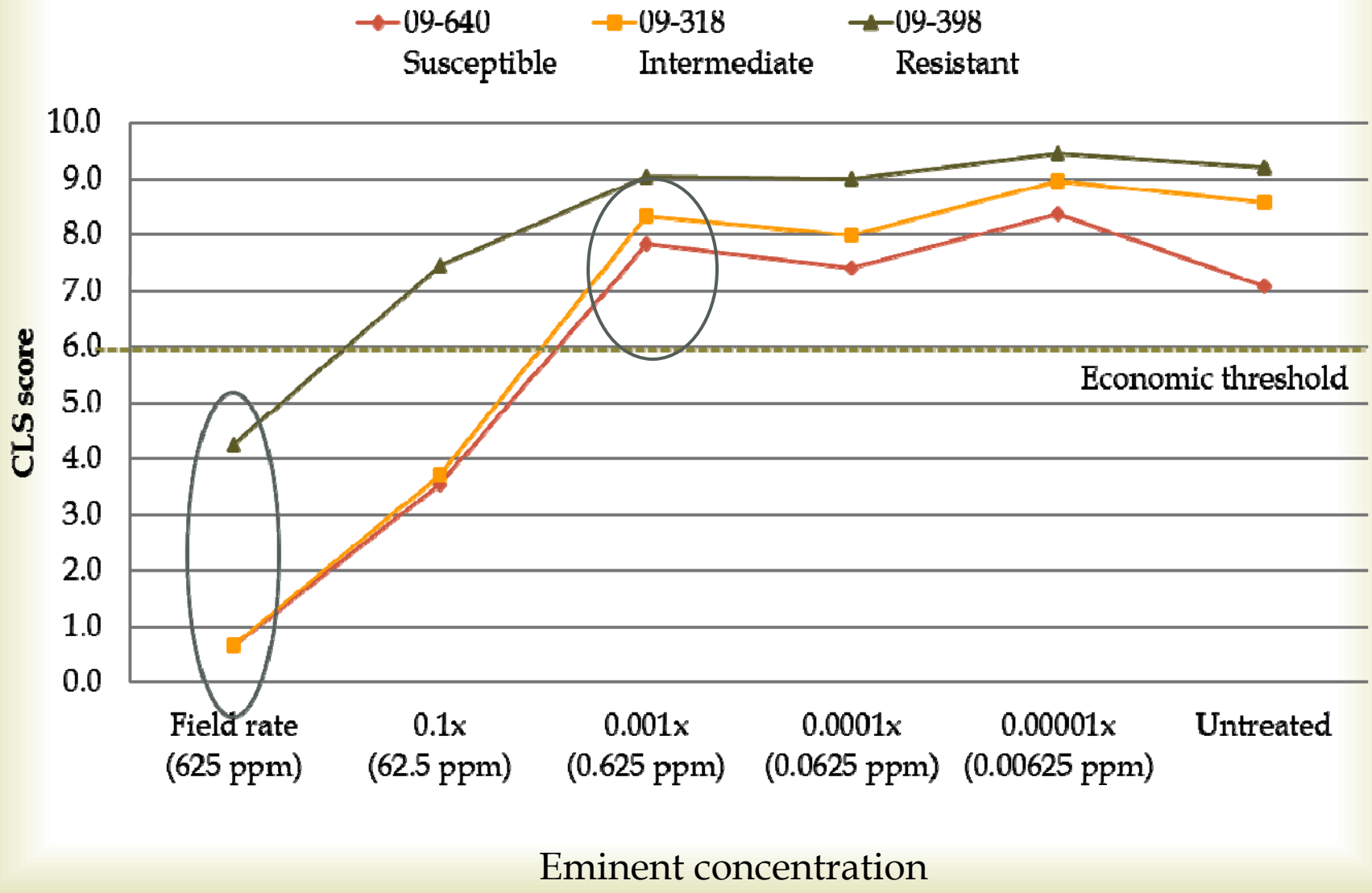


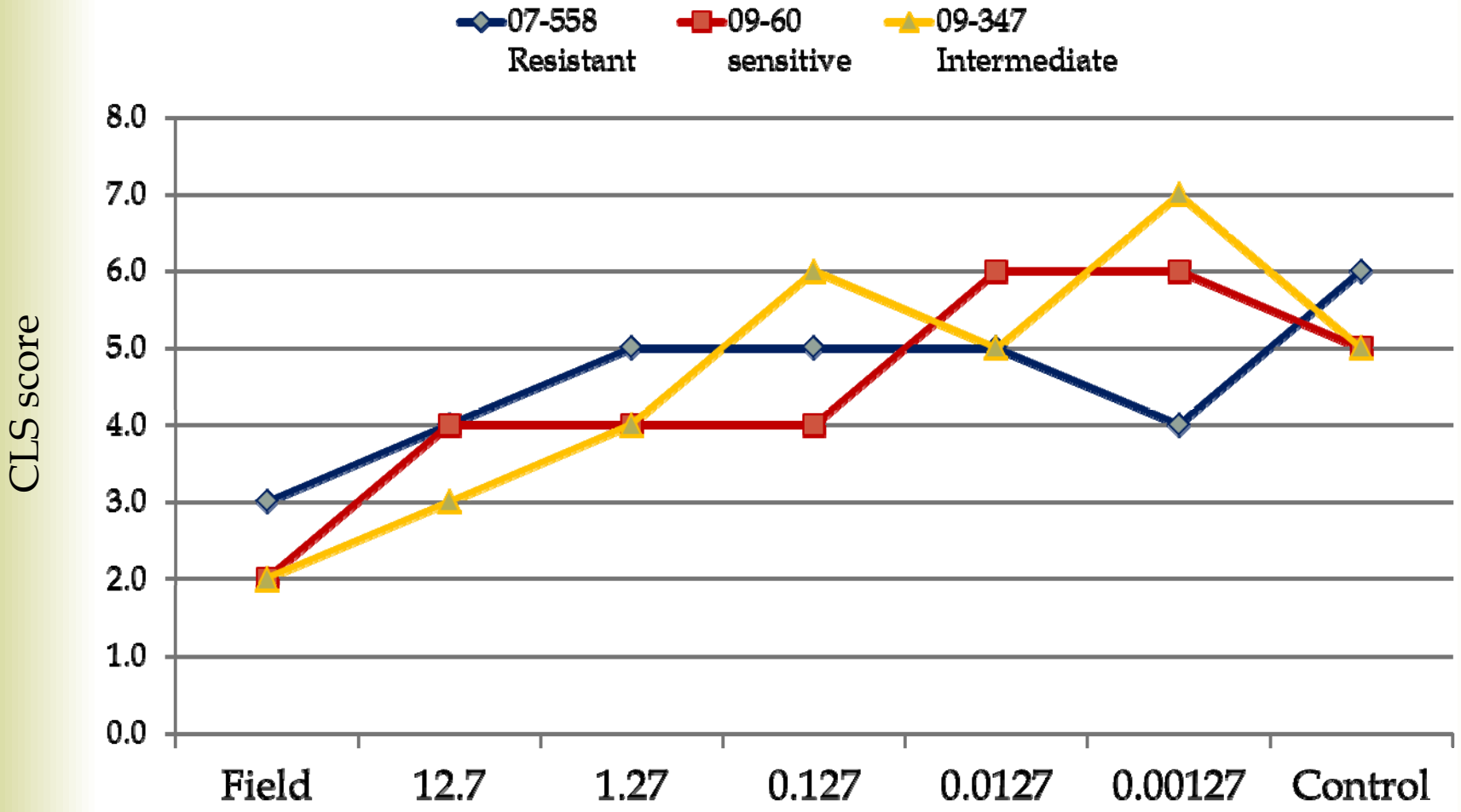
Figure B: Cercospora Leaf Spot Damage Categories

Jones, RK and Windels,C.E. 1991.A management model for Cercospora leaf spot of sugarbeets Minnesota Extension Service AG-FO-5642E.

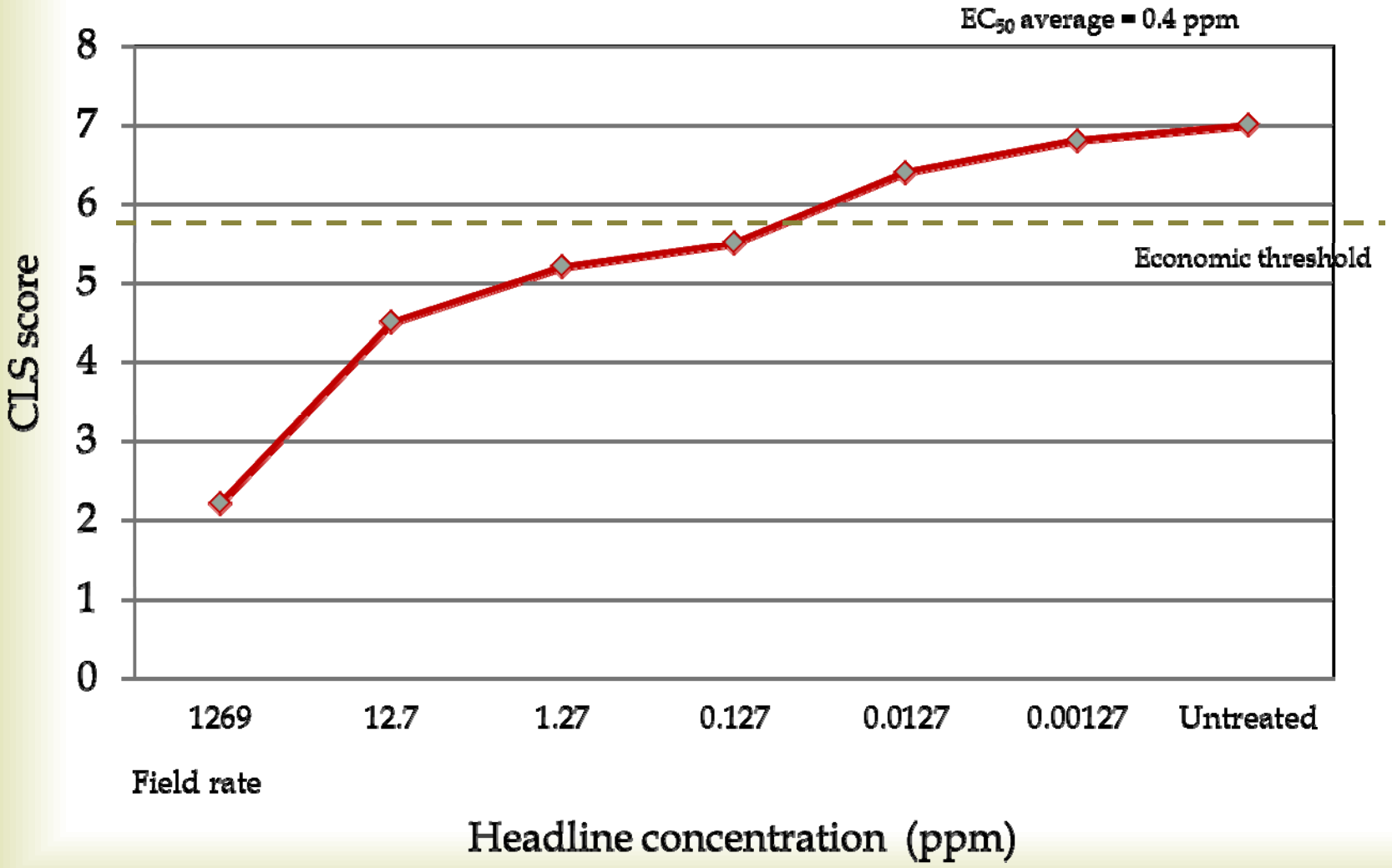
Sensitivity of *C. Beticola* to Eminent



Sensitivity of *C. beticola* to Headline



Sensitivity of *C. beticola* to Headline across all isolates (resistant, intermediate and susceptible)



Summary

- Increased resistance to Cercospora in 2010, likely due to higher disease pressure
- Some isolates were found to be resistant to Eminent, Inspire and Headline fungicides with EC_{50} values > 1
- Resistant isolates affected fungicide efficacy
  - Reduced disease control in field trials with resistant isolates
- Reduced disease control in GH trials showed more disease with isolates with higher EC_{50} values
  - Disease control by Eminent was lost at a concentration of fungicide less than 0.625 ppm
  - Disease control by Headline was lost at a concentration of fungicide less than 0.127 ppm
- Field and GH data demonstrate a loss of disease control with resistance levels present in the *C. beticola* population in the RRV