Sensitivity of *Alternaria solani* to azoxystrobin

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INTRODUCTION

Potato early blight, caused by *Alternaria solani* plays an important role in potato health and can limit yield. Early blight is an annual production concern and control of this polycyclic disease depends primarily on multiple fungicide applications. The very visible and frequent applications of fungicides focus grower and environmentalist attention on this disease. Selection pressure on *A. solani* for fungicide resistance has been relatively high, due to multiple fungicide sprays, particularly on tomato and potato crops in the United States. In Wisconsin during 2001 and 2002, approximately 80% of the total commercial potato acreage was treated with strobilurin fungicides (average of 3 applications) alternating with EBDC or chlorothalonil (CH) sprays. Decreased sensitivity to strobilurin fungicides has been reported in laboratory and field isolates of other fungi. This project is designed to develop information needed to augment current disease and crop management systems with a focus on resistance management. In 1997-98, early blight disease progress curves (DPC) for WI field plot treatments with azoxystrobin (AZ) resembled flat lines. During the past five years, the level of early blight control with AZ appears to be progressively declining. The objective of the field trials was to test AZ and CH alternations to determine the effect on isolate sensitivity.

MATERIALS AND METHODS

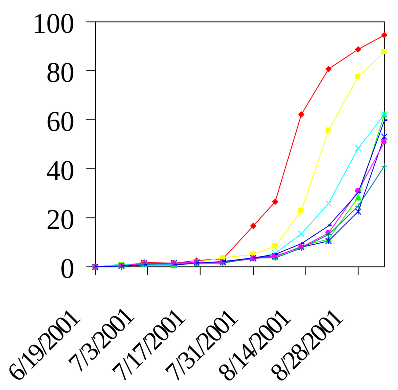
Isolates of *A. solani* were collected in Wisconsin during 1998 prior to strobilurin exposure in order to determine a baseline sensitivity distribution. During 2001 and 2002 populations of *A. solani* were collected from fungicide trials at Hancock Agricultural Research Station Hancock, Wisconsin. Eight treatment protocols (4 replicates), received up to six sprays of Quadris® (Table 1). Treatments were set up to evaluate any differences in foliar early blight progression and relative area under the disease progress curves (RAUDPC) in the field. Mean ED_{50} (µg/ml) to AZ, the active ingredient of Quadris®, of *A. solani* collected in the treated plots to were then determined in the laboratory. Sensitivity tests on fungicide amended agar were performed on individual monoconidial *A. solani* isolates (n>18) from 1998 (baseline), 2001 and 2002 as described by Olaya et al. (1998, 1999) with slight modifications.

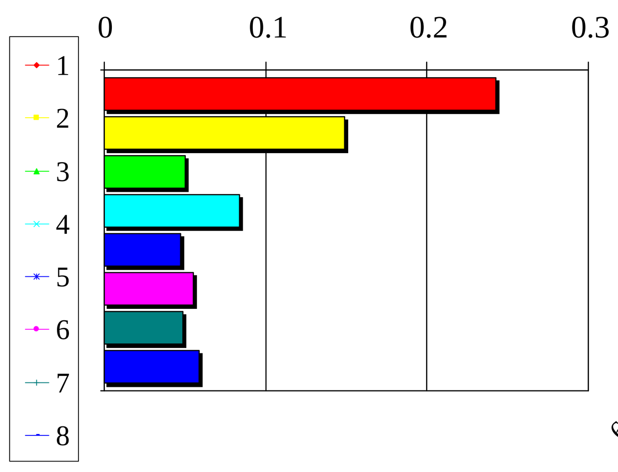
Treatment Chemicals	Rate/Acre Product	Rate/Acre a. i.	Schedule Summary	ED_{50} (µg/ml) 2001 Mean	2001 St. Dev	2002 Mean	2002 St. Dev
1. Untreated				0.214	0.179	0.509	0.558
2. Bravo Zn 4.17 F	2.13 pt	1.11 lb	Weekly	0.174	0.236	0.458	0.281
3. Quadris 2.08 F Bravo Zn 4.17 F	0.39 pt 2.125pt	0.1 lb 1.11 lb	Appl 1 Remaining applications	0.507	0.397	0.830	0.559
4. Quadris 2.08 F Bravo Zn 4.17 F	0.39 pt 2.125pt	0.1 lb 1.11 lb	Appl 1,3 Remaining applications	0.676	0.517	0.722	0.381
5. Quadris 2.08 F Bravo Zn 4.17 F	0.39 pt 2.13 pt	0.1 lb 1.11 lb	Appl 1, 3, 5 Appl 2, 4, 6, 7, 8, 9	0.636	0.288	0.420	0.19
6. Quadris 2.08 F Bravo Zn 4.17 F	0.39 pt 2.125pt	0.1 lb 1.11 lb	Appl 1,3,5,7 Remaining applications	0.469	0.374	0.552	0.369
7. Quadris 2.08 F Bravo Zn 4.17 F	0.39 pt 2.125pt	0.1 lb 1.11 lb	Appl 0,2,4,6,7 Remaining applications	0.523	0.351	0.630	0.403
8. Quadris 2.08 F Bravo Zn 4.17 F	0.39 pt 2.125pt	0.1 lb 1.11 lb	Appl 0,2,4-7 Remaining applications	0.733	0.297	0.727	0.360

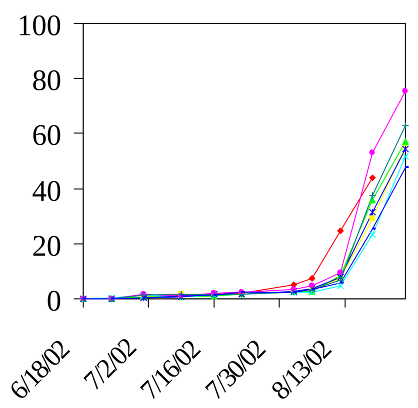
Table 1. 2001 and 2002 Hancock fungicide trials spray schedule.

RESULTS

Disease progress curves (DPC) and RAUDPC of plots treated with Quadris® and Bravo Zn ® alternations showed a significant difference (LSD p=0.05)in disease control compared to plots left untreated and treated with Bravo Zn ® alone in 2001, but not 2002 (Figs. 1-4), there were only slight differences in DPC and RAUDPC between alternating Quadris® and Bravo Zn® spray regimes (Figs. 1-4) were detected. *In-vitro* ED_{50} (µg/ml) values based on relative spore germination of isolates from 2001 and 2002 fungicide trials showed differences based on treatment origin (Table 1). The frequency distribution of isolate sensitivity also showed variability from treatment to treatment (Figs. 5,6) and a shift in sensitivity was detected in all treatments compared to the baseline already established for this pathogen. The mean *in-vitro* ED_{50} from a random sample of baseline isolates (n=33) from 1998 was 0.039 (µg/ml) with a min. of 0.01 and max. of 0.07.







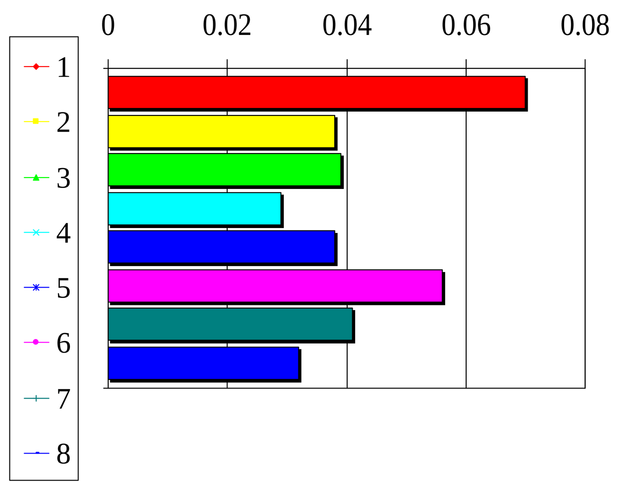


Fig. 1. Foliar disease severity (%) for 2001*.   Fig. 2. RAUDPC for 2001*.   Fig. 3. Foliar disease severity (%) for 2002*.   Fig. 4. RAUDPC for 2002*.

*Treatments correspond to treatment # in Table 1.

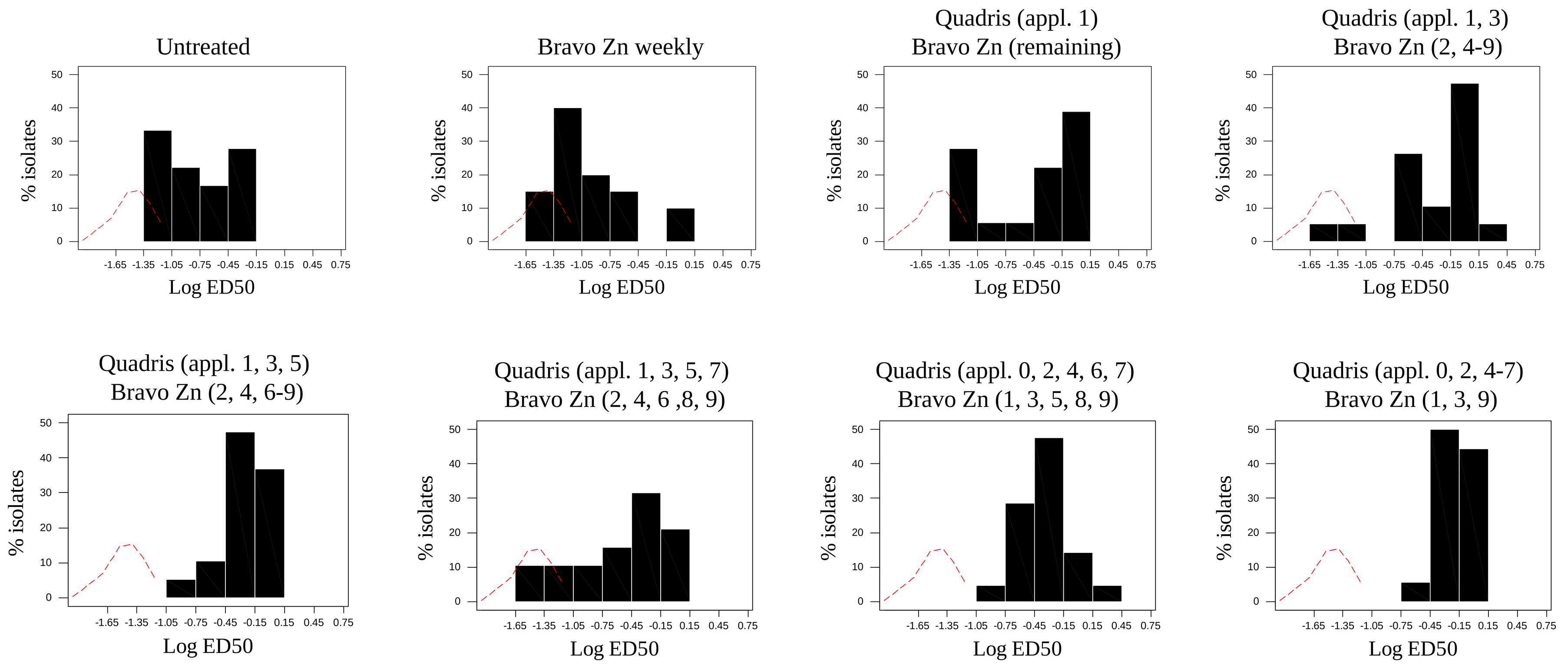


Fig. 5. Frequency distribution of isolate *in-vitro* sensitivity (log concentration) from early blight control plots in 2001, red line represents normal distribution of baseline isolates.

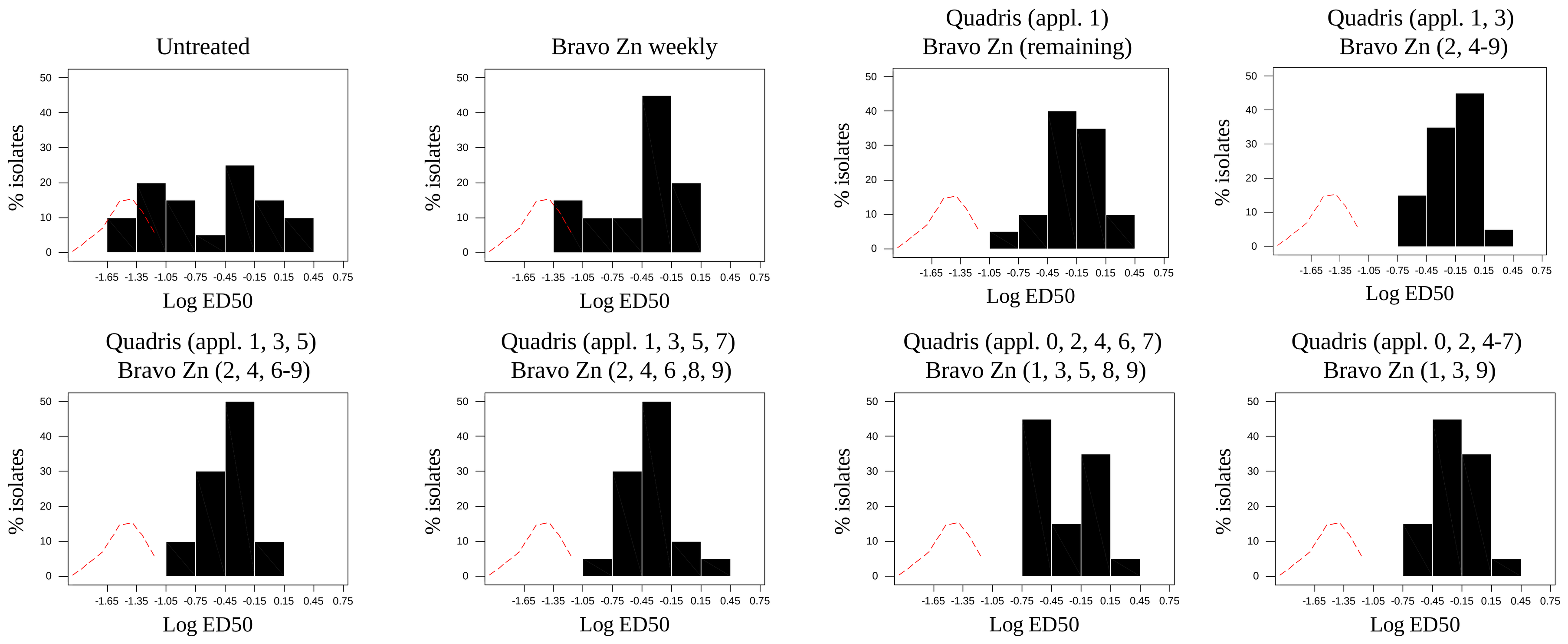


Fig. 6. Frequency distribution of isolate *in-vitro* sensitivity (log concentration) from early blight control plots 2002, red line represents normal distribution of baseline isolates.

SUMMARY AND DISCUSSION

The results indicate a difference in mean sensitivities determined *in-vitro* ED_{50} (µg/ml) in sub-populations related to spray treatment and a shift in sensitivity from baseline isolates. This range of *in-vitro* sensitivities may not be expressed *in-vivo* and may not affect disease control. During 2001 and 2002, the fungicide field programs totaling 10 sprays tested alternations of AZ (1-6 sprays) and CH (4-9 sprays). The *in-vitro* and variability of *A. solani* isolates sensitivity to AZ (ED_{50}) was lowest in the untreated control in 2001 and for 3 applications of Quadris® in 2002 (p=0.05). Two application of Quadris® provided similar efficacy and S-shaped DPC's to other tested alternations. The frequency of reduced sensitivity isolates was also high in the untreated control where the fungicide selection pressure was low indicating that the number of reduced sensitive isolates in this experimental field is already high (strobilurin fungicides have been tested in this station since 1995 and at least three applications per year).Information from this research may be used to determine effective resistance management strategies for azoxystrobin and other strobilurin fungicides under commercial conditions.

FUTURE DIRECTIONS

Protective activity of azoxystrobin for the control of early blight will be tested on whole plants to determine *in-vivo* sensitivities. The sensitivity distribution of *A. solani* populations from major production fields in Wisconsin will be determined. Statewide monitoring of commercial fields was initiated for the 2002 growing season and will continue in 2003, along with further fungicide testing. Recommendations to potato growers include:

1. Limit the number of QUADRIS® or any other strobilurin fungicide to less than 1/3 of total sprays.
2. Use QUADRIS® or any other strobilurin fungicide early in season alternated with chlorothalonil or mancozeb.
3. Never apply back-to-back QUADRIS® or any other strobilurin fungicide.
4. Tank mix QUADRIS® or any other strobilurin fungicide with chlorothalonil or mancozeb or use formulated combinations.

REFERENCES

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