

### Effect of Fire on a Seed Bank Pathogen and on Seeds of Its Host *Bromus tectorum*

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#### Introduction

The generalist pathogen *Pyrenophora semeniperda* (Brittlebank and Adam) Shoemaker occurs primarily in cheatgrass (*Bromus tectorum* L.) seed banks, where it causes high seed mortality (Beckstead et al. 2007; Meyer et al. 2007). How does fire impact survival of a fungal seed pathogen, *P. semeniperda*, versus survival of the seeds of its cheatgrass host, the invasive *Bromus tectorum*? If fire completely destroys the pathogen, then cheatgrass seeds surviving the fire would be able to establish free of this natural enemy. Conversely, if the pathogen has high post-burn survival, then cheatgrass recovery from a post-fire seed bank could be negatively impacted.

#### Methods

We investigated this question in a series of laboratory and seed bank studies. In the laboratory, we determined the 50% thermal death point (TDP<sub>50</sub>, temperature causing 50% mortality) for cheatgrass seeds and for three life stages of the pathogen. Each were subjected to a range of temperatures in a muffle furnace (20 (control), 65, 100, 125, 150, 200 and 300°C) for 5 minutes and evaluated in subsequent viability assessment. Pathogen viability was assessed by placing the heat-treated life stage next to a bait seed during incubation. Seed viability was assessed via a germination test. In the field, we took advantage of two natural wildfires in cheatgrass monocultures in Utah and Washington, USA. Seed bank samples were taken from burned and adjacent unburned areas within a month of the fires. Samples were processed to remove all apparently viable and pathogen-killed cheatgrass seeds. Apparently viable seeds were incubated for 4 weeks at 20°C and scored as germinated, viable but dormant, killed in incubation by the pathogen, or nonviable/unfilled.

#### Results and Conclusions

Results showed that the ability of the seed pathogen to survive high temperature and subsequently infect adjacent host seeds decreased with increasing temperature and varied among life stages. The TDP<sub>50</sub> for the pathogen across all life stages after a 5-minute heat treatment was 164°C (Fig. 1a). The conidial stage experienced 50% mortality at a lower temperature than the mycelial and stromatal stages, indication that conidia are more susceptible to fire. The TDP<sub>50</sub> for seeds (148°C) was 10% lower than the mean TDP<sub>50</sub> for the pathogen (Fig. 1b), indicating that the seeds would be killed at a lower temperature than the pathogen. Wildfire dramatically reduced viable seed density at two sites; the Rattlesnake Mountain site had a 98% reduction, while the West Mountain site had an 85% reduction (Fig. 2a). The potential inoculum load for *P. semeniperda* measured as the density of field-killed cheatgrass seeds with stromata varied significantly between sites (Fig. 2b); however, fire only had a marginally significant ability to reduce the inoculum load. The ability of the pathogen to survive fire at the mycelial stage, internally in seeds, was indicated by the lack of any significant difference between burn treatments in density of incubation-killed seeds (Fig. 2c). Integrating our laboratory TDP<sub>50</sub> measurements with the seed bank data from wildfires, it is clear that annual grassland fires in our study were not hot enough to eliminate *P. semeniperda* from the seed zone. We conclude that *P. semeniperda* is as well-adapted to frequent, low-intensity fire as its cheatgrass host. Fires do not necessarily create an escape from this pathogen, thus allowing for post-fire cheatgrass expansion.

#### References

- Beckstead J, Meyer S, Molder C, Smith C. (2007) A race for survival: Can *Bromus tectorum* seeds escape *Pyrenophora semeniperda*-caused mortality by germinating quickly? *Annals of Botany* 99:907-914.
- Meyer S, Quinney D, Nelson D, and Weaver J. (2007) Impact of the pathogen *Pyrenophora semeniperda* on *Bromus tectorum* seedbank dynamics in North American cold deserts. *Weed Research* 47: 54-62.

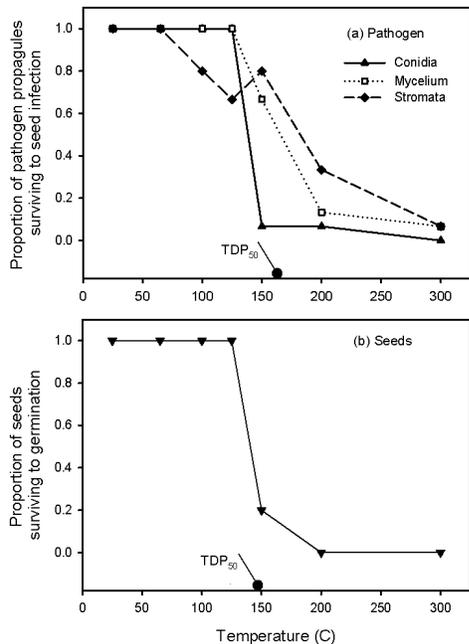


Figure 1. Thermal death curves showing the effect of radiant heat after 5-minute heat treatments on survival of *Pyrenophora semeniperda* life stages (a) and cheatgrass (*Bromus tectorum*) seeds (b). Thermal death points (TDP<sub>50</sub>; temperature at which 50% of the individuals experience death) are indicated for the average of all pathogen life stages (a; TDP<sub>50</sub> = 164°C) and for cheatgrass seeds (b; TDP<sub>50</sub> = 148°C).

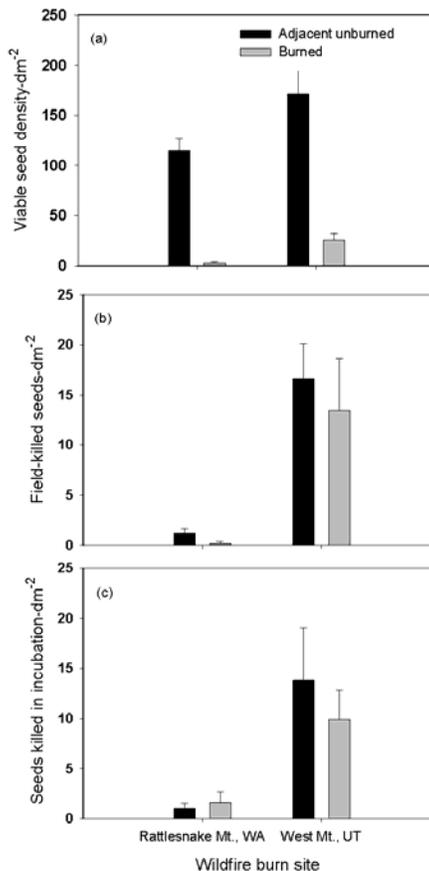


Figure 2. Effects of wildfires at Rattlesnake Mountain, Washington and West Mountain, Utah on cheatgrass (*Bromus tectorum*) seed bank viable seed density (a), field-killed seed density (b), and density of seeds killed in incubation (c); mean + 1 SE). Data represent ten (West Mountain) or twenty (Rattlesnake Mountain) soil samples collected from each treatment combination.