

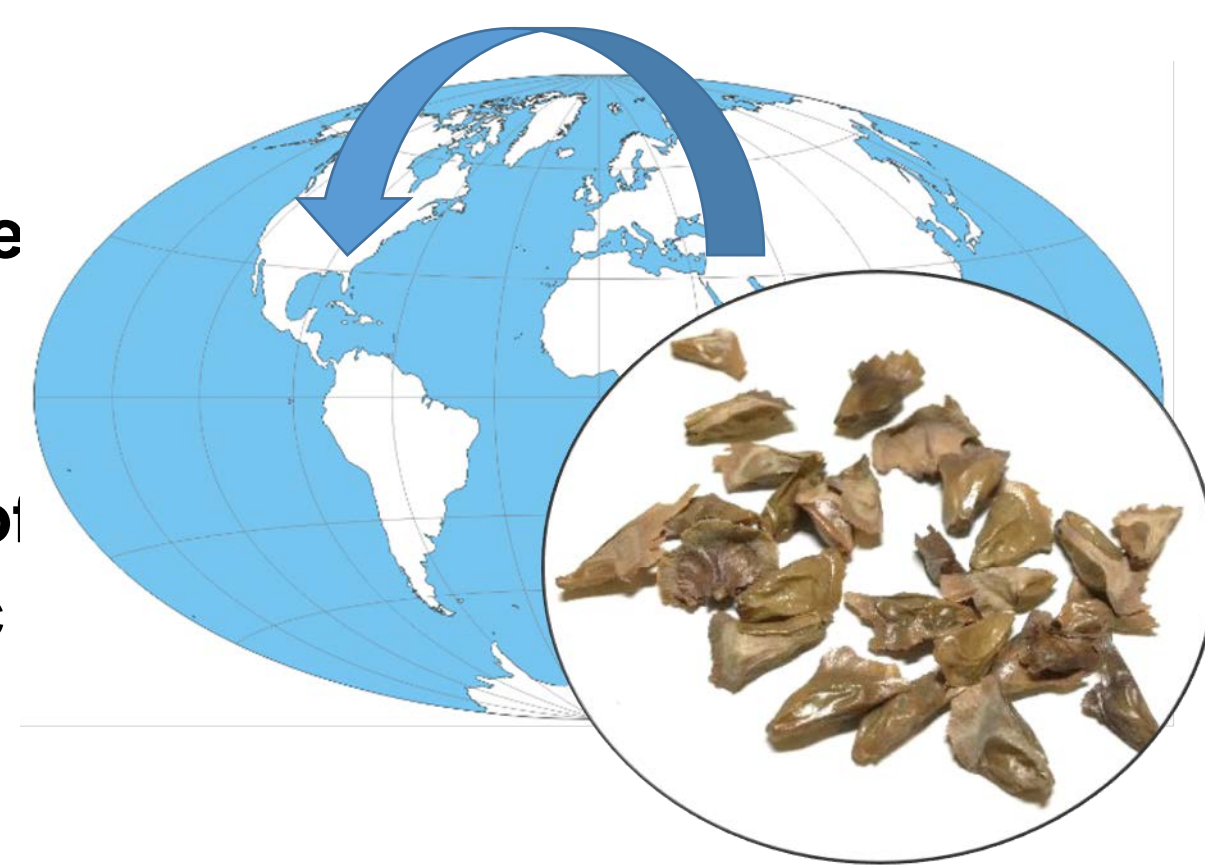
Heat treatment - A potential approach of killing *Megastigmus* larvae in imported conifer seeds

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Introduction

The production of Nordmann fir and Turkish fir Christmas trees is increasing, particularly in the Pacific Northwest where they now account for approximately 10% of the total trees grown. Domestic conifer nurseries mostly rely on the importation of seeds from natural stands in the Republic of Georgia and Turkey to produce the planting stock of these species.



Insect pests currently threaten the consistent supply of imported seeds, and none are more common than conifer seed wasps from the genus *Megastigmus*. These chalcid wasps lay eggs within premature seeds while still in the cone, and the larvae nourish themselves on resources meant for the seed embryo. They can lie dormant within seeds for several years even after the cone has matured. Within the past few years, APHIS PPQ has returned or destroyed considerable numbers of imported seed shipments at U.S. plant introduction stations due to the x-ray detection of live *Megastigmus* larvae in infested seed. APHIS PPQ currently has records of 15 species/subspecies of *Megastigmus* that are considered to be quarantine pests and there are currently no APHIS approved treatments for *Megastigmus*-infested conifer seeds, so importers have no recourse.

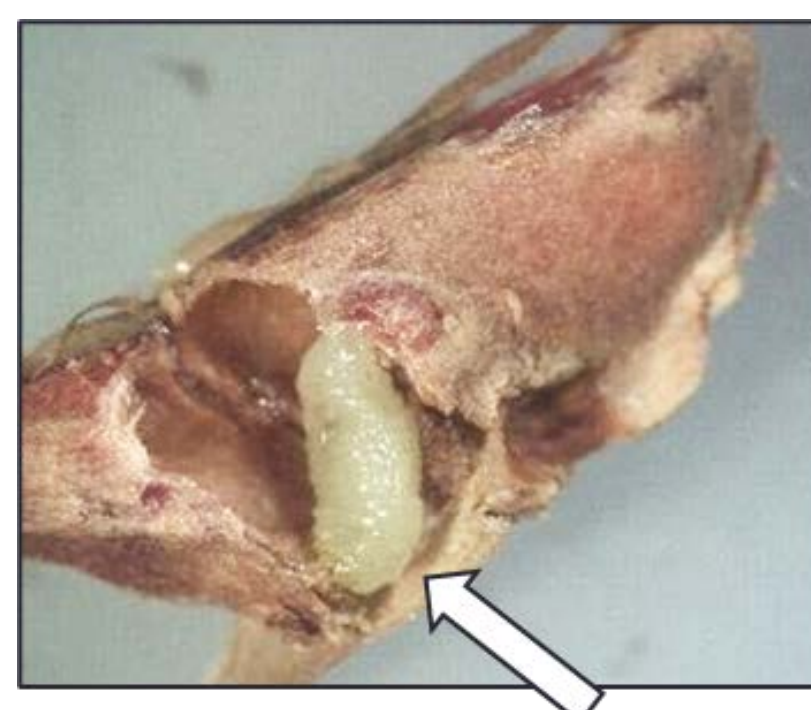
Previous research on the native *Megastigmus strobilovius* has shown that exposing infested Douglas-fir seed to 45C for 27 to 33 hours was effective in killing larvae in infested seed. This heat treatment also had no adverse effect on seed germination and subsequent growth of seedlings. If heat treatment of Nordmann and Turkish fir seed was shown to be effective in killing larvae and have no adverse effects on seed germination and seedling growth, it would provide seed importers and regulatory agencies with a technique that could be used to treat infested seed.

Objective

Determine threshold heat treatment temperatures and durations required to kill *Megastigmus* larvae in infested Nordmann fir seed.

Materials and Methods

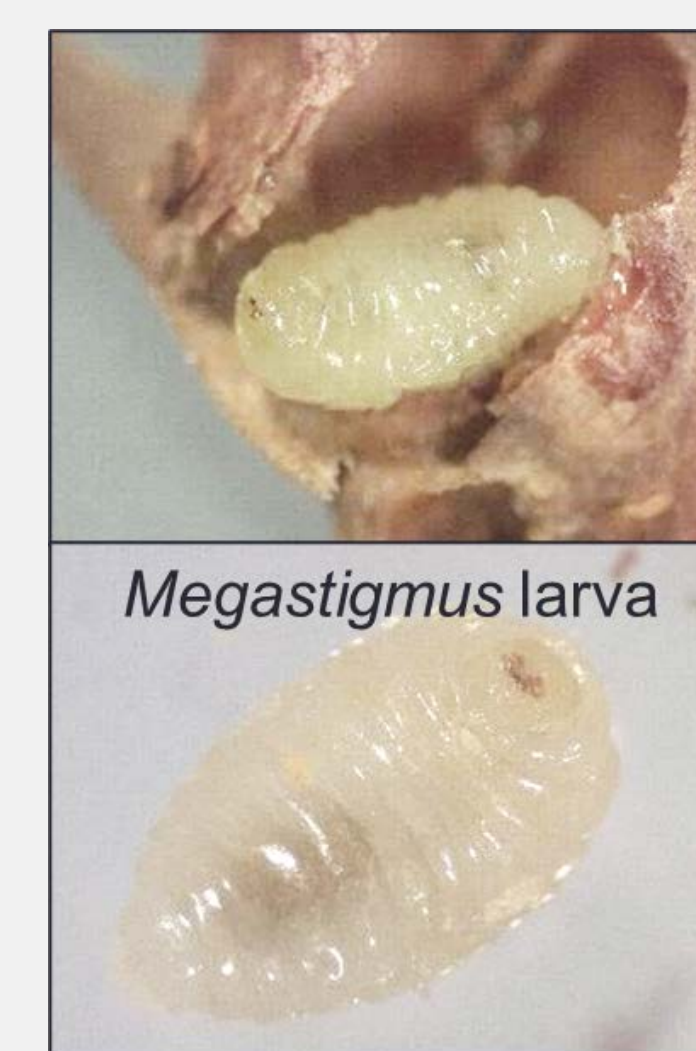
Megastigmus-infested Nordmann fir seed, confirmed with X-ray inspection and seed dissection, were obtained from seed processors in Oregon and Washington. Once obtained, infested seeds were stored at 0 C until used. A preliminary set of 24-hour heat treatment tests were conducted to identify the range of temperatures that were effective in killing larvae in seeds. Treatments included non-heated controls as well as 24-hour heat treatments at 30, 35, 40, 41, 42, 43, 44, and 45 C. Once these tests were completed, a series of replicated tests were then conducted to determine the effect of heat treatment duration (24, 36 and 48 hours) on the efficacy of 45 C heat treatments in killing larvae. Checks consisted of non-heated seeds that were held at room temperature.



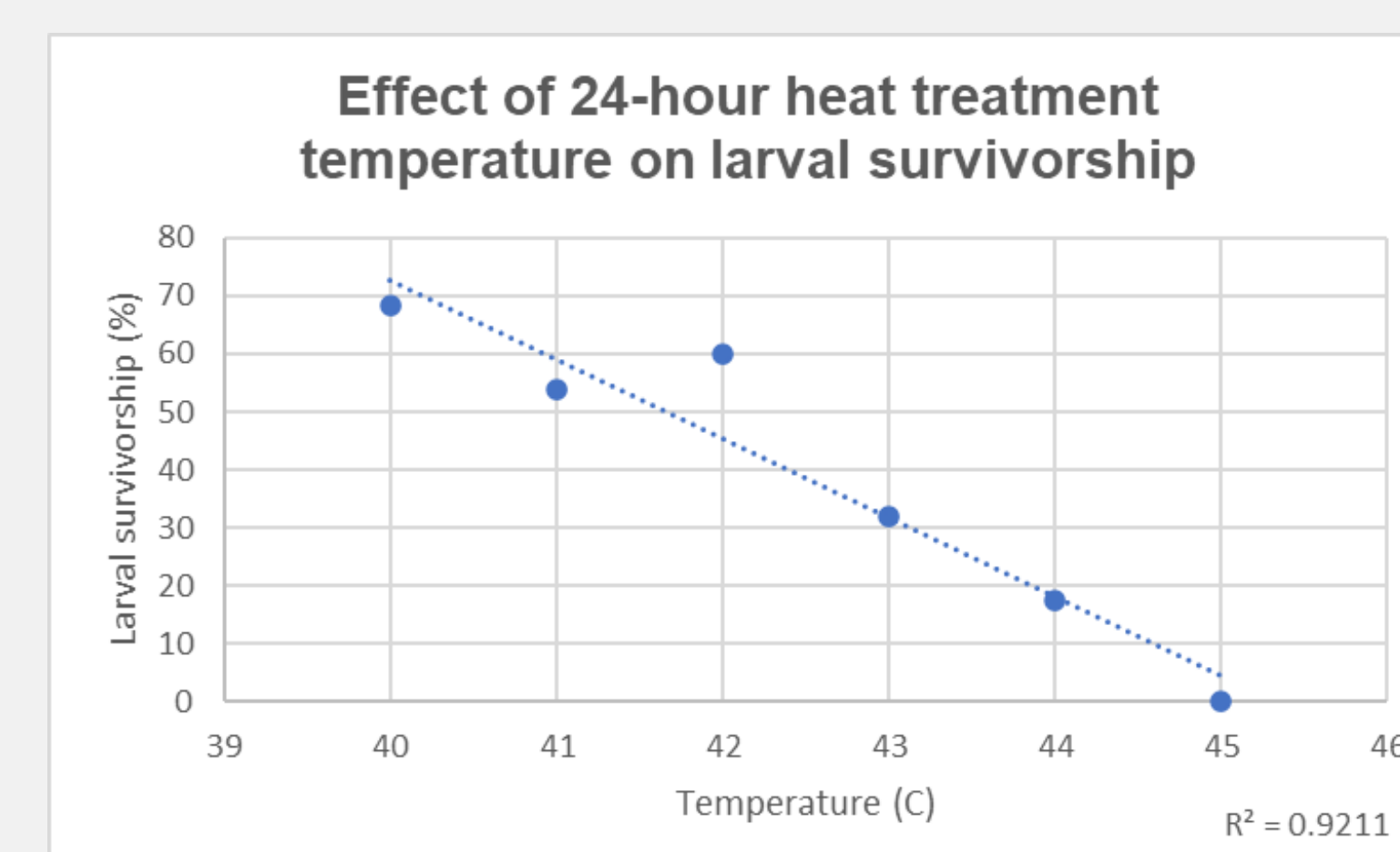
Prior to heat treatment, seeds were conditioned at room temperatures for 24 hours. Post treatment, the seed was stored at room temperature for 72 hours, which provided time for the killed larvae to darken, making it easier to determine if larvae were dead during seed dissection. The infestation levels in the seed lots that were used in our trials varied and was <5%. Given this variation, sufficient numbers of seeds in each test were dissected to evaluate the condition of a minimum of 30 larvae per treatment. Data loggers were used to confirm heat treatment temperatures. In addition to monitoring the efficacy of treatments in killing larvae, the effect of the treatments on the moisture content of the seeds was also determined.

Results

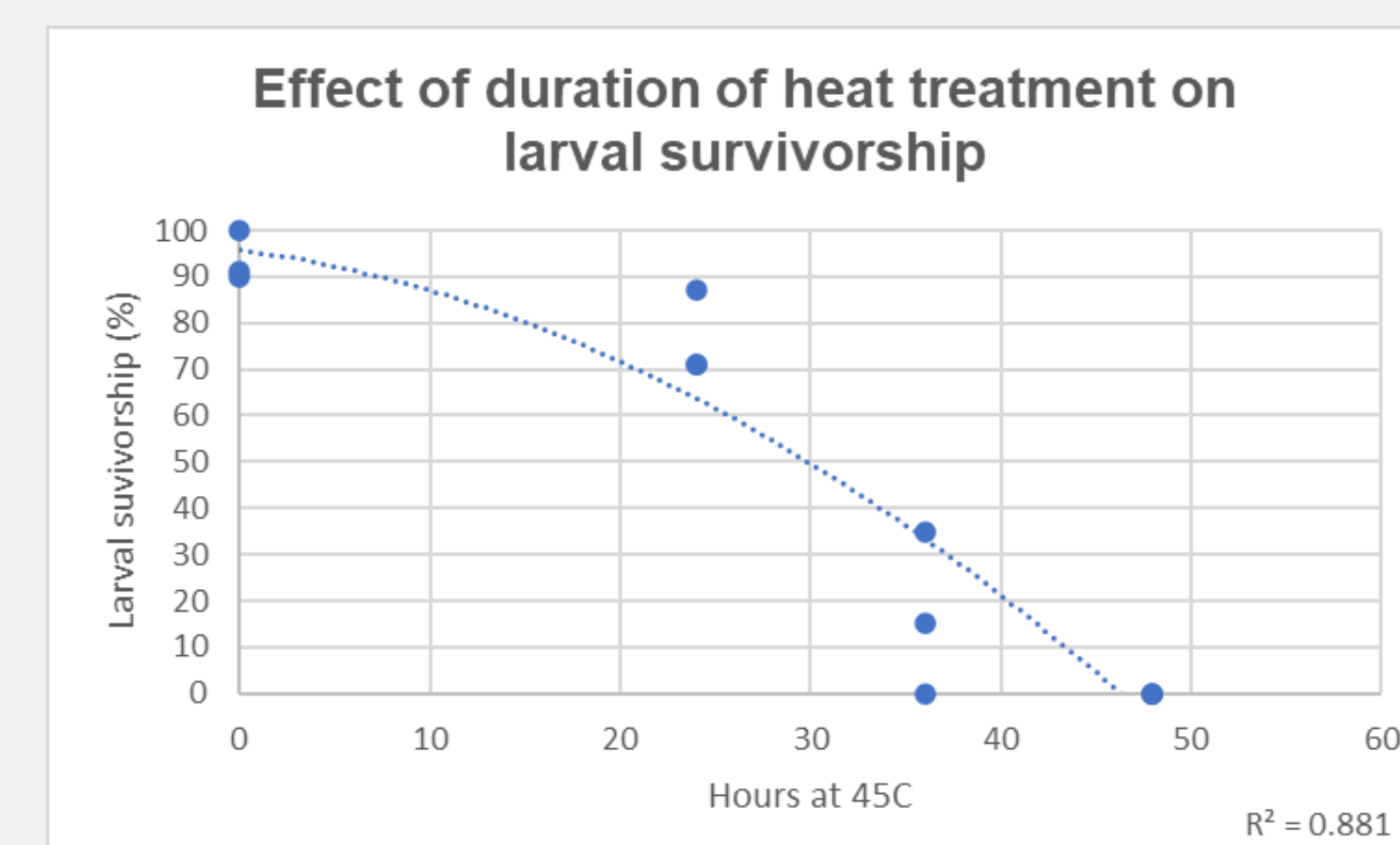
Compared to the plump, creamed colored live larvae that moved when touched, dead larvae were dark and often shrivel.



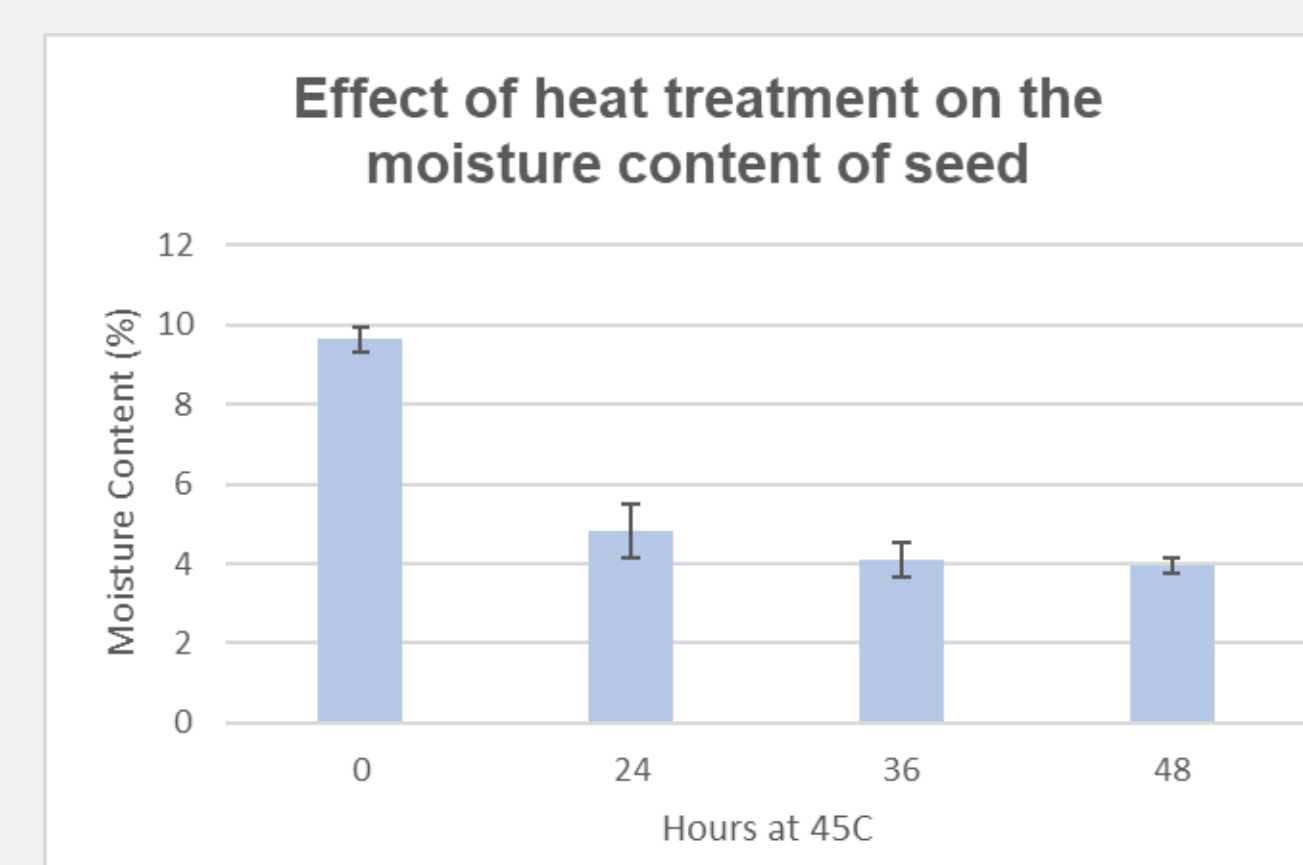
In the 24-hour heat treatment trial, 71.4% of the larvae were alive in the non-heated check seeds and temperatures ≤ 40 C had little effect on the viability of larvae (data not shown). At temperature between 40 and 45 C, there was a highly correlated ($R^2 = 0.9211$), negative linear relationship with larval survivorship.



Unlike the 24-hour preliminary test, data from the heat duration trial indicated that the duration of treatments at 45 C had to be at least 36 hours before all the larvae were killed in some replicates. A 48-hour long treatment provided 100% kill of all the *Megastigmus* larvae in the infested seed.



As expected, heat treatments also reduced the moisture content of the seed. Most of the reduction occurred during the first 24 hours of treatment.



Ongoing Research

While promising, additional trials are currently underway to determine what effect a 48-hour long heat treatment at 45C has on the viability and vigor of heat-treated Nordmann, Turkish, Trojan and noble fir seed. Tests are also being done to determine if the heat treatments have any adverse effects on the growth of seedlings.

Selected References

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