

Hamilton KD; Fields PG, Hervet VAD, Paliwal J, Nadimi M (2021) Low temperature as an alternative to fumigation: An example using *Acanthoscelides obtectus*. Page 276. In: Jayas DS, Jian F (eds), Proceedings of the 11th International Conference on Controlled Atmosphere and Fumigation in Stored Products (CAF2020), CAF Permanent Committee Secretariat, Winnipeg, Canada.

Low temperature as an alternative to fumigation: An example using *Acanthoscelides obtectus*

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ABSTRACT

Insects are affected by temperature in all aspects of their biology: ecology, reproduction, behaviour, physiology and biochemistry. Stored-product insects reproduce between 15 and 35°C. Above and below these temperatures insects can move, but cannot complete their development. Temperatures below 5°C and above 40°C insects cannot walk, and will eventually die. Between -7 and -25°C insects freeze and die instantaneously. There are significant changes to these general patterns depending upon species, life stage, acclimation and diapause. For example, insects can become 10 times more resistant to cold if acclimated at cool temperatures (5 to 15°C) before being exposed to sub-zero temperatures.

Acanthoscelides obtectus (Say), the bean weevil, is capable of causing severe damage to stored whole pulses by boring through the seed coat to consume the cotyledons and contaminating sound grain with dead bodies and excreta. It is originally from South America, but is now found across North America, Europe and Africa. It is a quarantine pest for India and China. More natural control measures are being evaluated worldwide as replacements for chemical control. Here, we tested the survival time of different life stages of *A. obtectus* at -5°C. The life stages studied were: eggs and adults (external stages) and young larvae, old larvae and pupae (internal stages). Since *A. obtectus* larvae feed within seeds, 2D soft X-rays were used to confirm if a seed was infested with a single larva and to determine the internal life stage of it. The insects were exposed to -5°C for 0, 1, 2, 3, 4, 7, 10 and 14 d. Treated insects were monitored at 25°C and 65% RH to assess survival. Eggs were considered as alive if they emerged as larvae; young larvae, old larvae and pupae were considered alive if they emerged as an adult; adults were considered as alive if they were able to walk. The eggs had a lethal time to 50% mortality at -5°C (LT₅₀) of 2.3 d, young larvae, old larvae and adults had a LT₅₀ of approximately 4 d. Data for pupae is not available at this time. The supercooling point (freezing point) of eggs was -26.8°C and for adults it was -14.0°C. Preliminary encouraging results establish that cold treatment of bean weevils could be used as an effective alternative to fumigation.

Keywords: Quarantine; X-ray, Pulses, Alternative to methyl bromide