

CO₂ and Biogas Applications for Controlling Pests in Seeds

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INTRODUCTION TO PESTS IN SEED STORAGE

Insect pests can result in substantial losses of stored seed. In West Africa, cowpea bruchids (*Callosobruchus maculatus*) caused up to 100 percent damage of cowpea seeds stored for a few months (Sallam 1999). Primary pests are those that, in larval stage, feed within intact kernels. Others, such as the saw-toothed grain beetle (*Oryzaephilus* sp.), are secondary pests that attack damaged seeds. Elevated carbon dioxide CO₂ levels

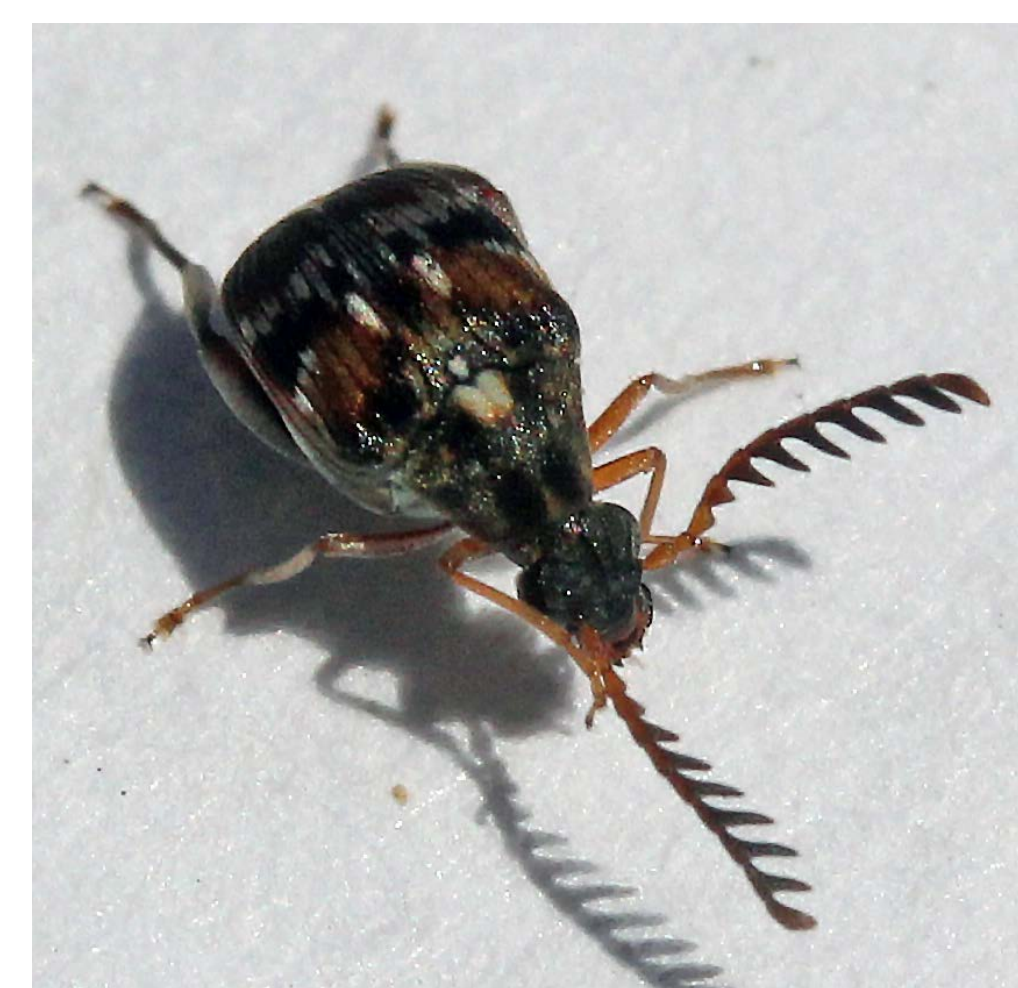


Figure 1. Cowpea bruchid (top) and cowpea seed covered with bruchid eggs (bottom). Source: Tim Motis

have been shown to kill insect pests in sealed containers (Navarro 2006). Most insects in stored seeds are killed when the atmosphere in the room or container is comprised of 60% or more CO₂. Elevated CO₂ levels have little or no adverse effect on the germination of stored seeds (Gupta *et al.* 2014; Navarro *et al.* 2012).

ECHO network member, Ken Thompson, commented that “For resource-poor communities, CO₂ or biogas can be easily generated at a low cost (*Asia Note 28*)”

QUESTIONS

- ✓ Can household biogas systems be used to safely kill insects in stored seeds?
- ✓ Can a CO₂ generator be made from simple materials be used to kill seed pests in storage containers?

BIOGAS

Preliminary Trial

In a trial by ECHO staff in Florida, sawtoothed grain beetles in a 2-L plastic container of maize seed were controlled with biogas from an inner tube (Figure 2). Beetles stopped moving within hours. Weeks later, no live insects were observed in the container.



Figure 2. Sawtoothed beetle (left) and biogas fumigation setup (right). Source: Tim Motis

Areas for Future Research

- How large of a biogas system is needed to generate enough gas to control insects in various-sized containers?
- What widely available, inexpensive materials could be used to connect a biogas system to a container of seeds, and then seal the container after flushing it with biogas?
- How long does the biogas need to be sealed in the container to achieve insect mortality? This could be worked out for various species of insect pests.
- What are some options for scrubbing out H₂S? If present in biogas-fumigated containers, does most of the H₂S volatilize when the seed container is opened, and what are the implications for human consumption and seed viability?

CO₂

Preliminary Trial

CO₂ can be generated with yeast, a sugar source and water. To control bruchids in cowpea seeds, a generator was built using 0.5 L (2 cups) of sugar. CO₂ was generated for about two weeks, and all cowpea bruchids in the jar were killed. Figure 3 explains components used and how CO₂ is flushed through the system.

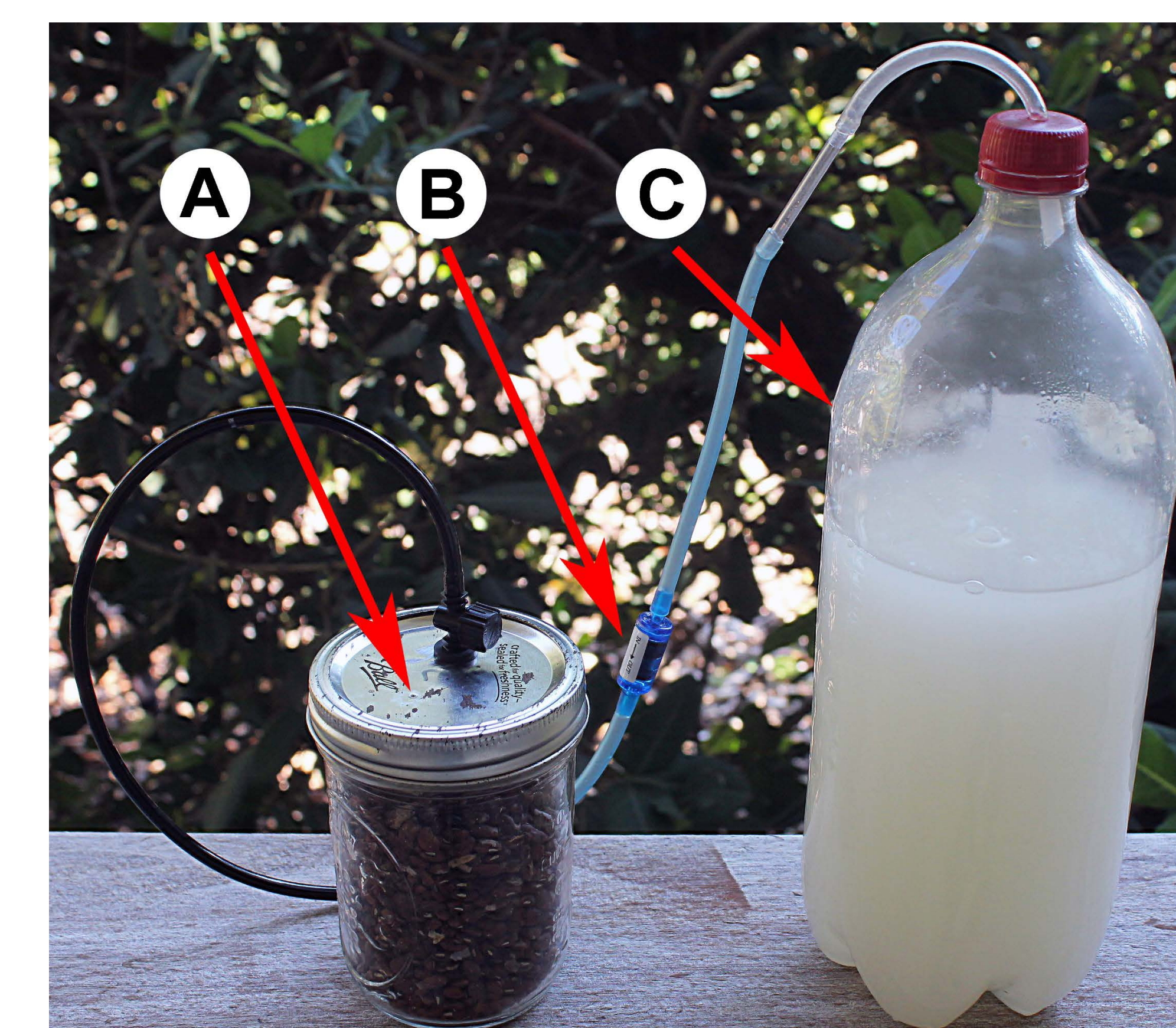


Figure 3. An airtight jar of weevil-infested seeds (A) is flushed with CO₂ generated in a bottle (C) containing water, yeast, and sugar. An optional check valve (B) ensures one-way transfer of CO₂ into the jar of seeds. As CO₂ builds up in the seed jar, gas is exhausted through a tiny hole (A) in the lid. Source: Tim Motis

Areas for Future Research

- What ratios of sugar, water, and yeast will achieve optimum results?
- For a given method or recipe, how much time is needed for oxygen to be replaced with CO₂ in a container? Is there a simple way to determine when the oxygen has been replaced by CO₂?
- How long do various species of insects need to be exposed to CO₂ to kill larvae, adults and eggs?