P-072

Development of CO_2 releasing beads to control soil borne insect pests - first results

Vemmer M. [1#] **and Patel A. V.** [1*]
[1] University of Applied Sciences, Engineering and Alternative Fuels - Bielefeld, Germany
marina.vemmer@fh-bielefeld.de,* Supervisor

INTRODUCTION AND OBJECTIVES

Carbon dioxide (CO_2) is an attractant for several soil-living organisms. A number of pest insects use CO_2 for host location (Doane *et al*. 1975, Hibbard & Bjostad 1988, Bernklau *et al*. 2005). The most important example is the western corn rootworm (*Diabrotica virgifera virgifera*), whose larvae use CO_2 to locate the roots of living corn plants on which they feed when having followed the upward gradient (Strnad *et al*. 1986) (figure 1 A).

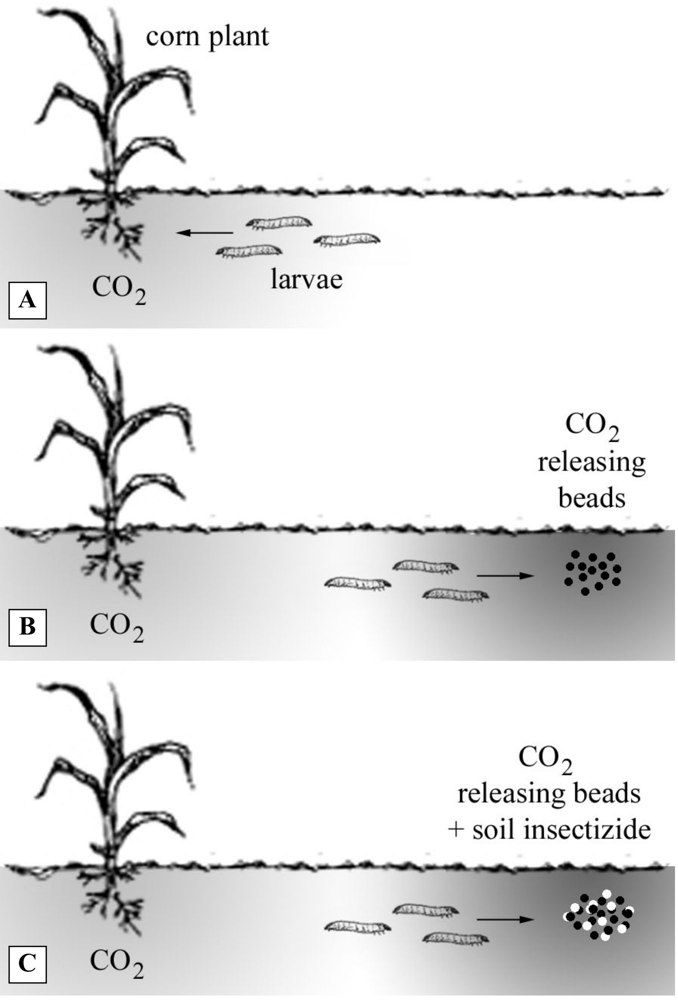

Figure 1: Larvae use CO_2 to locate the roots of living corn plants (A). Larvae are attracted by artificial CO_2 sources and die of starvation (B). Larvae are attracted by artificial CO_2 sources and are killed by an insecticide (C).

The destruction of the roots and physiological stress of the plants caused by the larval feeding leads to considerable crop losses. The western corn rootworm is economically one of the major corn pests worldwide (Schwabe *et al*. 2010). In the USA there are losses of about one billion USD due to yield loss and expenditure on pest control (Chandler 2003).

Attractants based on CO_2 might have the potential to control the western corn rootworm. Laboratory experiments have shown that artificial CO_2 sources can attract larvae of *D. virgifera* and lure them away from the roots (Bernklau *et al*. 2004, Vidal 2010, unpubl.) (figure 1 B). Further experiments show an increase in the efficacy of a soil insecticide when it is combined with a CO_2 source (Schumann *et al*. 2011) (figure 1 C).

Due to the potential of artificial CO_2 sources to control pests, there is a high interest in the systematic development of plant protection products based on attractants and in formulation methods to improve stabilization, release and handling. The purpose is to achieve a long-time release of CO_2.

MATERIALS AND METHODS

Formulation of artificial CO_2 sources

An artificial CO_2 source was encapsulated in moist Ca-alginate beads without and with additives. A negative control was composed of the same formulation but without active ingredients or additives.

Determination of CO_2 formation rates

CO_2 was quantified using a Carbon Dioxide Meter with pump-aspirated sampling (Vaisala CARBOCAP® GM70), which calculates P_{CO2} by measuring the absorption of an infrared beam by CO_2 molecules. All P_{CO2} values are presented as ppm (volume) by the measuring instrument.

For the determination of CO_2 formation rates, the amount of CO_2 produced by 1 g moist beads in 1 h in a closed chamber with a volume of 50 mL at room temperature was measured. The formation rates are calculated as mL CO_2 produced by 1g moist beads in 1 h.

Measuring CO_2 gradients in soil

Boxes (12 cm x 34 cm) were filled with an autoclaved mixture of flower soil and sand in a one to one relation (w/w). 10 g CO_2 releasing beads were placed in 8 cm depth in the middle of each box. The boxes were kept at room temperature. The moisture of the soil, that influences the CO_2 release as well as the CO_2 determination, was adjusted by weighing the boxes and adding water to compensate the evaporation. Furthermore, the residual moisture was periodically controlled with a moisture analyzer (Sartorius MA35).

CO_2 gradients in soil were detected using the pump aspirated sampling method. Therefore, a drain tube connected with the pump was inserted into the soil. The sampling positions were 0 cm, 5 cm, 10 cm and 15 cm on both sides starting from the middle of the box to obtain a result that corresponds to the mean value of two determinations per sampling position. The values are presented as ppm (volume).

RESULTS AND DISCUSSION

Figure 2 and figure 3 show a significant CO_2 emission for encapsulated artificial CO_2 sources without and with additives compared to the control.

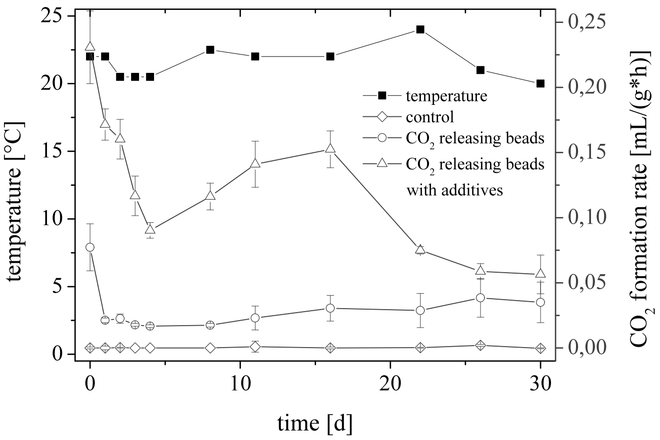

Figure 2: CO_2 formation rates of the control, of CO_2 releasing beads without and with adjuvants over time.

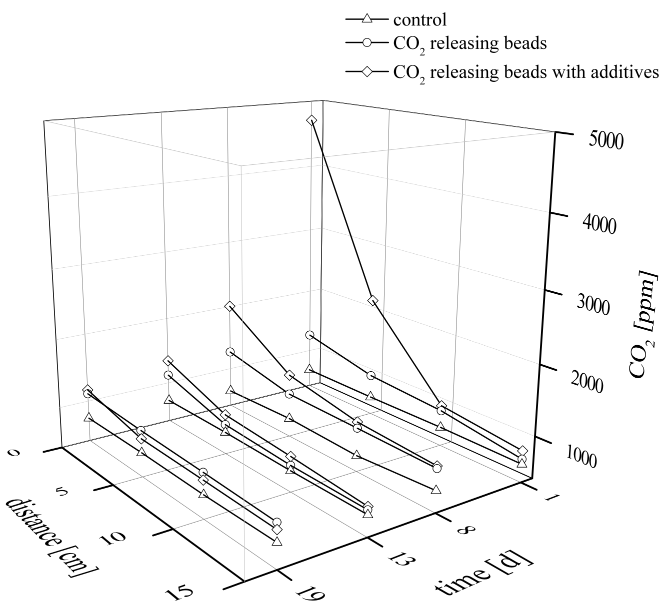

Figure 3: CO2 gradients in soil of the control, of CO2 releasing beads without and with adjuvants over time.

The CO_2 formation rate of the encapsulated artificial CO_2 source with additives is markedly higher at the start than that of beads without additives. Both rates are decreasing rapidly right at the beginning. But the formation rate of the beads with additives is increasing after several days, and it is always higher than that of the beads without adjuvants. After 7 weeks there is still a significant CO_2 emission for both.

In soil, at the beginning, there is analogously a higher CO_2 gradient for the beads with additives compared to the beads without additives. The gradients are continuously decreasing during the first 2 weeks. After 19 days, there is still an increased amount of CO_2 in soil compared to the control, but there is no gradient detectable.

CONCLUSIONS

An artificial CO_2 source was successfully encapsulated in Ca-alginate beads. Experiments have shown a significant CO_2 emission over several weeks and detectable CO_2 gradients in soil over 2 weeks.

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